SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1910.

GENERAL PHYSICS.

1067. *Friction.* **F. Charron.** (Comptes Rendus, 150. pp. 906-908, April 11, 1910.)—Discusses the effect of the layer of air between two bodies sliding one over the other, and also treats of friction in a vacuum. When two bodies slide, one over the other, there is in general a mutual tearing out of particles of each surface, which renders the phenomenon complex. In the case of pure friction (where no tearing out of particles takes place) a phenomenon presents itself which is hidden in the ordinary case. As the relative velocity of the two surfaces increases, the coefficient of friction decreases, and becomes zero for a particular velocity which the author calls the critical velocity. This diminution of friction is due to a layer of air which interposes itself more or less between the two surfaces for velocities less than the critical velocity, and which separates them altogether for velocities equal to, or greater than, the critical velocity. Experiments were carried out with specimens of copper, brass, and graphite, sliding over a plane glass plate, which was caused to rotate in its own plane round a vertical axis. The body to be experimented on was placed on the disc and attached by two fine and flexible threads to a kind of balance, the beam of which, with the two threads, formed a triangle. Small mirrors and a divided scale allowed the displacement of the beam to be exactly determined, and from this the friction could be deduced. On increasing the velocity of rotation of the disc the displacement of the beam became less and less, the friction finally becoming so small that the threads were scarcely straightened. This small force is only due to the viscosity of the gaseous layer. The thickness of the layer could be measured by putting a source of light in the plane of the disc, and using a microscope with micrometer eyepiece. The thickness of the layer was found not to be uniform, but greater at the front than at the back. The mean value varied with the conditions of experiment, and could attain a value of several hundredths of a mm. With a "rubber" of graphite whose rectangular base had an area of 1 cm.^{2}, of weight 1·4 gm., and loaded with different weights, the following critical velocities (which can only be regarded as a first approximation) were obtained :—

Load.	Critical Velocity.
1·4 gm.	192 cm. per sec.
2·4 „	262 „ „
3·4 „	290 „ „
6·4 „	437 „ „
11·4 „	770 „ „

When the apparatus was set up in a case which could be evacuated, it was found that there were notable variations of the frictional force with a pressure of only 2 or 3 cm. of mercury. When the pressure was reduced to 1 mm. of mercury, it was found that the coefficient of friction was sensibly independent of the velocity, thus confirming the conclusions in the first part of the paper as to the effect of the layer of air. A. W.

1068. *Influence of Temperature on Mechanical Properties.* **M. Rudeloff.** (Electrochem. and Metallurg. Ind., N.Y. 7. pp. 455–456, Oct., 1909. Abstract of paper read before the Internat. Assoc. for Testing Materials, Copenhagen, 1909.)—The tenacities of various kinds of iron and steel have been determined at various temperatures by heating the specimens in vapour baths attached to the testing machine, temperatures being measured by means of thermo-couples attached to the specimens. The tensile strength of wrought iron increases with rise of temperature to a maximum at 250° C.; at the same time the elongation falls to a minimum at 150° C. and then increases again. Soft steel attains a max. tensile strength at 200–300°, and a minimum elongation at 150°–200°. Cast iron (grey foundry) maintains its strength up to 400°, but at 600° has depreciated about 60 per cent. Malleable iron shows a slight increase in tenacity up to 275°, after which there is a marked decrease. F. C. A. H. L.

1069. *Proportions of Chain Rings.* **T. Robson.** (Engineering, 89. pp. 565–566, May 6, 1910.)—Records tests carried out, under the direction of the chief mechanical engineer of the North-Eastern Railway, in order to determine the safe limit of loading chain-rings. Those tested were taken from stock in the ordinary manner. The results are therefore such as may be expected to obtain under similar conditions in everyday practice. The Board of Trade specify a proof load which causes the chain to elongate, but no alteration in shape is allowed. A 60-ton vertical testing machine was used for the tests. The ring was measured for deformation across horizontal diam. Load was applied by increments of $\frac{1}{10}$ ton. After each increment load was removed to see if there was any permanent set, fine-pointed trammels being used for this measurement. Prior to testing, dimensions of the rings were carefully taken. If D is mean diam. of the ring, and d the diam. of iron in the ring, then since the bending moment increases as D, and the resistance to bending varies as d^3, the value of d^3/D was calculated for each ring. A chart was constructed with values of d^3/D on vertical scale, and load in tons at which distortion commences on horizontal scales. From all the results so plotted on squared paper a mean straight line was drawn, and the equation connecting the load, W, at which distortion commences, with the dimensions of the rings is $W = 18{\cdot}7d^3/D$. Taking that as the proof load, and allowing half the proof load for working load, as is the practice with chains, we obtain a similar equation, with 9·85 instead of 18·7. A useful chart has been prepared from the results giving dimensions of rings (of different sizes of chain iron and corresponding diams. of ring) for different loads. Since a ring is used as an end attachment for a chain, a formula showing the relative dimensions of chain and attached ring is given. If C is diam. of iron in a short-link chain, the proof load is $12C^2$. Substituting this for W, we obtain the relationship $0·64C^2 = d^3/D$. The author considers that, although a more scientific method of measuring the point of deformation could have been adopted, yet errors of workmanship inseparable from ordinary smithed work would have a greater influence than any difference in method of measuring the point of deformation. C. A. M. S.

1070. *Descent of a Sphere in Viscous Liquid.* **A. B. Basset.** (Nature, 83. p. 521, June 30, 1910.)—Stokes' formula for the terminal velocity of a sphere descending in a viscous liquid under the action of gravity has been recently tested by J. Zeleny and L. A. Keehan [see also Abstracts Nos. 788 and 1071 (1910)], and they found that the values of the velocity furnished by it were considerably larger than those which they obtained from their experiments. Since Stokes' formula is obtained on the hypothesis of no slipping, it furnishes an *inferior* limit to the velocity, and consequently the discrepancy between theory and observation cannot be explained on any hypothesis that slipping takes place. The author thinks the explanation may be as follows: The equation determining the current function contains the term $d\psi/dt$, the origin being some *fixed* point in the line of motion of the sphere; and if the motion be referred to the centre of the sphere as a moving origin, $d\psi/dt$ must not be put equal to zero when the motion is steady, but must be replaced by $Vd\psi/dz$, where V is the constant velocity of the sphere. The retention of this term creates no difficulty so far as the integration of the differential equation for ψ is concerned, but the solution is quite different from that given by Stokes.

E. H. B.

1071. *Air-resistance to Falling Inch Spheres.* **E. H. Hall.** (Amer. Acad., Proc. 45. No. 16. pp. 380–384, May, 1910.)—Previously the author experimented on falling bronze spheres to detect a southerly deviation from the plumb-line vertical [see Abstract No. 970 (1904)]. He now uses the same spheres, which are 1 in. diam., to ascertain the air-resistance, again allowing them to fall from the tower of the Jefferson Physical Laboratory at Cambridge, Mass. The carefully measured height of fall is 2285 cm., whereas the time, from an electric chronograph, corresponds to a vacuum fall through 2321 cm. Taking the net accelerating force to be represented by $(mg - kv^2)$ dynes on the fall of m gm., the author finds $k = 0·00154$ nearly, where $m = 78·8$ gm. and $g = 980·4$ cm./sec.^{2} for sea-level at Cambridge, Mass. [Thus the "limiting" or "terminal" velocity, $\sqrt{mg/k}$, is of the order 6860 cm. sec.$^{-1}$.]

E. H. B.

1072. *Uniform Rotation on Relativity Principle.* **G. Stead and H. Donaldson.** (Phil. Mag. 20. pp. 92–95, July, 1910.)—Ehrenfest advances the problem of the rotation of a solid cylinder about its axis in connection with the principle of relativity [Abstract No. 18 (1910)]. He suggests that a contradiction is involved from the facts that any element of *circumference*, which must be moving in the direction of its length, tends to exhibit the usual shrinkage in the ratio $(1 - \beta)^{1/2}$, whereas any *radius* tends to remain unaltered, because it moves in a direction perpendicular to its own length.

A quantitative solution of the problem in the simpler case of a rotating disc is here given. The section of the disc is supposed to change from a plane to a cup-like surface. If s denotes the length of the curved section from the origin at the centre to a point where the inclination is ϕ, the intrinsic equation of the section is $(c^2 + \omega^2 s^2)^{3/2} \cos\phi = c^3$, where ω is the angular velocity and c is the speed of light. When ω is infinite the disc has become a filament of infinite density on its former axis, and of length equal to its original radius. It is thought probable that, for a disc of appreciable thickness, the plane form would be maintained during rotation, but that the material would be strained. The difficulty is discussed of experimentally detecting the curvature if it could be produced by rotation. E. H. B.

1073. *Relative Motion of Earth and Ether.* **H. A. Wilson.** (Phil. Mag. 19, pp. 809–817, May, 1910.)—This paper contains an attempt to reconcile the phenomena of the astronomical aberration of light and the negative results of the experiments made to detect relative motion between the earth and the ether, without supposing that bodies change in length when they are set in motion relative to the ether. It is claimed that this is here done, and that the facts available are sufficient to determine the relative motion at any point outside the earth. A theory is then described purporting to offer an explanation of the motion deduced. According to the theory of G. Stokes, aberration can be explained by supposing that the motion of the ether outside the earth is purely irrotational. It appears to be generally supposed that it is necessary in Stokes' theory for the ether to be carried along by the earth so that at the earth's surface there is no relative motion. That this is not the case was pointed out by Stokes himself. The statement frequently made that Stokes' theory fails because no irrotational motion of the ether can be found which satisfies the condition that the ether is at rest relative to the earth at the earth's surface, is therefore not really justifiable. As Stokes has shown, the path of a ray of light is unaltered by an irrotational motion of the ether, so, of course, aberration is unaffected by any such motion. Irrotational motion of the ether can only produce, at any rate, second order optical effects, so that such motion, if it exists, will be extremely difficult to detect. If it is not admitted that bodies change in length when set in motion relative to the ether, then the experiments of Michelson and Morley, in which the apparatus was turned about a vertical axis, show that at the surface of the earth the motion of the ether relative to the earth has no component in a horizontal plane. Regard the earth as at rest, and suppose the velocity of the ether far away to be v parallel to the axis of x. Take the centre of the earth as origin and its radius a. We then require to find a distribution of velocity having a velocity potential ϕ, such that $\phi_{r=a}$ is a constant, and that, for $r = \infty$, $-\partial\phi/dx = v$, $d\phi/dy = d\phi/dz = 0$. Regarding the ether as an incompressible fluid, it will be seen at once that this problem is precisely analogous to that of finding the electric field in the space surrounding a conducting sphere placed in a field which is uniform at a great distance from it. The solution is $\phi = v(a^3/r^2 - r)\cos\theta$, where θ is the angle between r and the axis of x. At the surface of the sphere $\phi = 0$, so that the velocity has no component parallel to the surface, while $-d\phi/dr_{r=a} = 3v\cos\theta$, so that the velocity perpendicular to the surface varies from $3v$ where $\theta = 0$ to θ where $\theta = \pi/2$. It appears, therefore, that the stream-lines crowd into the earth just as the lines of electric force crowd into a sphere of very high specific conductive capacity or into a conductor. A hypothesis is then developed in which, near each atom, the ether is in motion as though the atom contained a point source of ether and a point sink of equal strength, so that the ether entering the atom at the sink comes out again at the source. If the source and sink are very near together they will form a doublet, and we may imagine many such doublets in each atom. The experiments of Lodge, of Fizeau, and of Michelson and Morley are then discussed in the light of these views. It is concluded that the theory here put forward and the accepted theory of the stagnant ether both appear capable of accounting for all facts, and that it is difficult to devise a crucial experiment. E. H. B.

1074. *Influence of Comets on the Terrestrial Atmosphere.* **H. Deslandres.** (Comptes Rendus, 150. pp. 1281–1285, May 23, 1910.)—Although many of the supposed coincidences between the advent of large comets and terrestrial atmospheric disturbances are doubtless much exaggerated, the author thinks it profitable to inquire closely into the possible effect of a large stream of cometary matter on the condensation of vapours and consequent rainfall. The kathodic theory of cometary tails receives considerable support at the present time, and it has also been largely invoked for the explanation of many of the phenomena of terrestrial magnetism and auroral displays, chiefly through the researches of Goldstein, Birkeland, and Arrhenius. If the kathode rays emanating from the sun, encountering the small particles of the comet's tail repelled by the sun, produce rays analogous to Röntgen rays, these may penetrate deeply into the terrestrial atmosphere. We know that these rays produce ionisation and induce condensation of saturated vapours. It is also possible that there may be a generation of kathode rays accompanying the jets from the nucleus of the comet itself, the intensity of which might to some extent be estimated from the relative intensity of the continuous spectrum in different comets. C. P. B.

1075. *Semi-diurnal Lunar Tide.* **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 17–21, June 28, 1910.)—The records obtained with a 1000-kg. Wiechert astatic seismograph at Batavia during July–Dec., 1909, have been examined for the E.-W. component of the semi-diurnal lunar tide. Only observations between 7 p.m. and 8 a.m. could be employed owing to undulations of the ground set up by solar heat. As a control separate determinations were made for each hour from 10 p.m. to 5 a.m., and the mean result obtained for the tide was $0{\cdot}6248 \cos(2t - 251^\circ 58')$, the amplitude being expressed in mm. The sensitiveness of the seismograph has been deduced (1) from the deflections caused by known weights attached at definite points, (2) by determination of the period and indicator-magnification. The two methods are not in very good agreement, and the second is alone employed in the calculations as the discrepancy is ascribed chiefly to slow creeping in the deflection experiments. The E.–W. component of the tide is found to be $0{\cdot}01144'' \cos(2t - 251^\circ 58')$ as compared with a theoretical value—on the assumption of a perfectly rigid earth—of $0{\cdot}0155'' \cos(2t - 270^\circ)$. A. D. R.

1076. *Filamentous Structure of Upper Solar Atmosphere.* **H. Deslandres.** (Comptes Rendus, 150. pp. 1007–1013, April 25, 1910.)—In previous papers [Abstracts Nos. 81, 1190, 1867, 2003, 2004, 2007 (1909)] the author has described the method of work in obtaining records of the higher layers of the solar atmosphere by means of isolating the fine centre core of the K line of calcium in the ultra-violet or the strong red line H_α of hydrogen. The chief characteristic feature is the presence of long filaments showing as dark sinuous streaks often extending almost across the solar disc. They are not like sun-spots, confined to zones parallel to the solar equator, but there seems reason to believe that they are not irregularly distributed, although the law governing their occurrence is not yet known. In general the filaments round the polar circle are larger and better developed in the hemisphere and on the meridians where the spots and faculæ are relatively feeble. The long filaments are generally isolated, and often have two terminal portions inclined at about 120° to each other. When short the filaments are often aggregated in approximately polygonal figures, generally hexagons. **H. Deslandres**, **L. d'Azambuja** and **V. Burson.** (Ibid. pp. 1685–1689, June 20, 1910.)—Another feature now described is the development of a filament showing very great radial motion, at one time reaching 100 km. per sec. of ascent. The disturbance lasted at least 8¼ hours. Drawings from the negatives are given for several of the most notable features. C. P. B.

1077. *Velocity of Solar System in Space.* **Stroobant.** (Acad. Roy. de Belgique, Bull. 1. pp. 39–51, 1910. Nature, 83. p. 291, May 5, 1910. Abstract.) —From the velocities of 49 stars situated near Newcomb's latest value of the solar apex ($\alpha = 277{\cdot}5^\circ$; $\delta = +35^\circ$), the author derives 18·75 km. per sec. as the velocity of translation, and from 15 stars near the anti-apex he derives the value 21·55 km. per sec. It is found that the resulting velocity depends on the spectral type of star employed for reference. C. P. B.

1078. *Interpretation of Spectroheliograph Records.* **W. H. Julius.** (Konink. Akad. Wetensch., Amsterdam, Proc. 13. pp. 2–11, June 23, 1910.)—Hale and Ellerman have adhered to their view that the dark hydrogen flocculi are due to areas of increased hydrogen absorption [Abstract No. 320 (1910)]. To provide a further test the author reviews the question of asymmetry of the absorption lines—if due chiefly to absorption the reversal should be symmetrical, while if due to anomalous dispersion the widening of the lines would most likely be asymmetrical. C. P. B.

1079. *Effect of Magnetic and Gravitational Forces on the Moon.* **E. W. Brown.** (Amer. Journ. Sci. 29. pp. 529–539, June, 1910.)—Between the observed and computed place of the moon there is a difference which has been unexplained up to the present time. Its magnitude is too great for it to be attributed to error of observation, and the author seeks to inquire if any force whose existence is only suspected may be the cause of the discrepancy. The period of the term is about 270 years, and its magnitude about 12″. In the attempt to account for this numerous computations have been made. A possible effect of magnetic attraction between the earth and the moon was examined by supposing the magnetic fields of the two bodies to be equivalent to that produced by straight solenoids symmetrical with respect to their centres of figure. The chief reason why the effect of magnetic attraction may be capable of observation arises from the fact that the resultant force varies as the inverse fourth power of the distance, while gravitation varies as the inverse square. From this the negative result was obtained that the unknown inequality cannot be produced solely by the secular motion of the magnetic axis of the earth. Difficulties also appear in supposing an oscillation of the lunar magnetic axis, or a variability of the product of magnetic moments, but it is suggested that a thorough consideration of the effect of magnetic attraction on the motion of the moon about its centre of mass is desirable. An investigation into the gravitational effects of libration is not favourable to the view that a librational term contributes to the long-period inequality. C. P. B.

1080. *Polar Flattening of Jupiter's First Satellite.* **J. C. Solá.** (Comptes Rendus, 150. pp. 1224–1225, May 17, 1910.)—Observed with powers of 550 to 750 on the 38-cm. Mailhat equatorial at the Fabra Observatory, the satellite Io presents a conspicuous flattening which is probably greater than that of any other known body in the solar system. From the measures it appears that the equatorial plane of Io coincides with the plane of its orbit. The flattening was approximately determined as about 1 : 4. C. P. B.

1081. *Photographs of Jupiter, April,* 1909. **E. C. Slipher** and **P. Lowell.** (Phil. Mag. 19. pp. 488–497, April, 1910.)—Measures of the photographs of Jupiter taken during April, 1909, at the Lowell Observatory, Flagstaff, Arizona, have been made carefully for study of the dimensions of the planet and of the physical conditions. Determinations from five images on a plate taken April 14 gave the ellipticity = 1/14·8. The poles of the planet are distinctly darker than the rest of the object. From the positions of the cloud belts it appears that those near the equator are symmetrically distributed about it, regardless of the declination of the sun at the time. This would suggest that Jupiter's cloud covering is self-produced, indicating great internal heat setting up currents which are persistent in their main features for long periods of time. The persistence of the red spot and surroundings for so many years would point to a plastic rather than a gaseous condition for the Jovian material. A very interesting feature is the series of wisps lacing the equatorial belt. They always proceed from black spots of a triangular shape set on the edge of the north or south tropical belts. C. P. B.

1082. *Spectrum of Mars.* **W. W. Campbell** and **S. Albrecht.** (Science, 31. pp. 990–992, June 24, 1910. Paper read before the National Academy of Sciences, April, 1910.)—Observations were made with a specially designed spectrograph having a 5-in. plane Michelson grating (15,000 lines to the inch), second order spectrum, used in conjunction with the 36-in. refractor. The plates secured on Jan. 26, 27, and Feb. 2, 1910, failed to show any traces of water-vapour lines. On Feb. 3 two plates were exposed to the "*a*" region near $\lambda 6280$, which includes several oxygen absorption lines. These last were observed displaced by amounts corresponding to velocities of 18·8 and 17·4 km. per sec., the computed velocity being 19·1, so that if any outstanding lines were present the conditions appeared to be excellent for their detection. Here again, however, the terrestrial oxygen lines were not accompanied by Martian lines. The conclusion given is that the quantity of water-vapour existing above unit area in the equatorial atmosphere of Mars was certainly less than one-fifth that existing above Mt. Hamilton under the excellent conditions on Feb. 3. The air temperature was 0° C., relative humidity 88 per cent., absolute humidity 1·9 gm. per $m.^3$, and zenith distance 55°. Similarly the quantity of oxygen must be small in comparison with that in the earth's atmosphere. C. P. B.

1083. *Celestial Ejectamenta and the Origin of Cometary Bodies.* **H. Wilde.** (Chem. News, 101. pp. 229–231, May, 1910. Halley Lecture, Oxford Univ., 1910.)—The view that the solar system was formed by the successive condensations of a nebular substance has been more firmly established through the advances made in stellar photography. That the subsequent condensations of nebulæ into spherical bodies would be attended by the evolution of heat sufficient to make them vividly incandescent was to be expected. After the heat had attained its maximum, the self-luminous bodies would ultimately become dark bodies through radiation of their heat into free space. The planets would then consist of a solid external crust, covering a liquid shell, leaving the central parts in their primitive gaseous condition under great pressure. That comets are planetary ejectamenta, principally from the larger planets, might be reasonably inferred from the enormous force manifested by the ejections from other celestial bodies. The cause of the ejection was to be found in the conjunctive attraction of other planets acting on that part of the surface of the planet where the ejection took place. The orbital direction of the comet was determined solely by the position of the breach in the crust in relation to the orbital motion at the moment of discharge, and would be direct when its discharge coincided with the orbital motion of the planet and retrograde when it was in the opposite direction. And according as the discharge was more or less at right angles to the plane of the planetary orbit, so would the angular direction of the comet to the ecliptic be determined. **A. P. H.**

1084. *Observations of Halley's Comet.* **E. Esclangon.** (Comptes Rendus, 150. pp. 1095–1096, May 2, 1910.)—Observed on April 27, 1910, with the equatorial of the Bordeaux Observatory, the luminous head was accompanied by two distinct surfaces of discontinuity, shaped like the arms of the letter **V**, with the opening towards the tail and the junction at the centre of the nucleus. The two branches were somewhat curved, with their concavity directed towards the head of the comet. The nucleus, about 7 seconds of arc diam., was very brilliant and sharply distinct from the general luminosity of the coma. Several rays proceeded from the nucleus towards the extreme head of the coma. **J. Mascart.** (Ibid. pp. 1497–1499, June 6, 1910.)—At an altitude of 2715 m. on Mt. Guajara, Teneriffe, a series of photographic observations of the comet were arranged, 70 plates being secured. The tail was observed 110° long on May 16, and for several days the apparent brightness of the comet was greater than that of Venus. **J. C. Solá.** (Ibid. pp. 1659–1662, June 20, 1910.)—Observations with a 38-cm. Mailhat objective at the Fabra Observatory, show that the tail was in general composed of numerous long filaments. The diam. of the brilliant portion of the head was relatively small, about 110,000 km. The head was surrounded with extended nebulosity, generally asymmetrical with regard to the axis of the tail. The nucleus was about 3500 km. diam. on May 11. From May 31–June 4 a series of remarkable changes took place, evidenced by the production of secondary nuclei which altered in distance and position-angle. **C. Nordmann.** (Ibid. pp. 1732–1734, June 27, 1910.)—Observations have been made with a stellar photometer attached to a small equatorial coudé, on April 25, May 15 and 23, comparing the comet with neighbouring stars. The stellar magnitude of the nucleus was estimated as varying from 6·88 on April 25 to 5·77 on May 23, while that of the complete cometary head ranged from 3 to 1 mag. It would thus appear that the nucleus only contributed about one thirty-seventh part of the total light emitted by the comet's head. Then combining this with the measured dimensions of the nucleus and coma, it is calculated that the intrinsic brightness of the nucleus was about nineteen times that of the envelope. From measurements with coloured screens on May 15 and 23 it is thought that the light of the nucleus is largely, if not entirely, composed of reflected light from the sun. **C. P. B**

1085. *Transit of Halley's Comet, May* 18, 1910. **P. Cirera and Ubach.** (Comptes Rendus, 150. pp. 1494–1495, June 6, 1910.)—Records of atmospheric ionisation and variations of the magnetic elements were made at the Ebro Observatory, Tortosa, during the computed time of transit of Halley's comet. The coefficient of atmospheric dispersion was registered by the Elster and Geitel apparatus; the number of ions, their relative velocity, and the electric conductibility by Gerdien's apparatus. The conductibility was very strong, mobility small, and the number of ions very great. The magnetic observations indicate little or no disturbance which can be ascribed to cometary influence. **J. A. Lebel.** (Ibid. pp. 1372–1373, May 23, 1910.)—Observations of ionisation with a cylindrical condenser showed definite variations about the calculated time of transit of the comet, but similar changes have been noted by the author as accompanying barometric depressions, so that it is doubtful if any extra-terrestrial effect was really recorded. C. P. B.

1086. *Spectrum of Halley's Comet.* **A. Bernard** and **P. Idrac.** (Comptes Rendus, 150. pp. 1161–1164, May 9, 1910.)—A preliminary article on the comet spectrum was published in 1909 [Abstract No. 328 (1910)]; the present one gives the results obtained with a new instrument specially designed for the work. The photograph obtained on Jan. 7, 1910, indicates that the principal radiation was 3884. Others taken on Feb. 9, March 2, 3, 4, show the presence of other bands, the chief being near λ474, with fainter ones near λ408 and 438. Further, the band 388, which was most prominent in Jan., became of somewhat similar intensity to 474 during March. Photographs taken on April 26 only showed the band at 474. On May 4 the continuous spectrum of the nucleus was sharply defined. The spectrum of the comet was represented by two well-defined condensations at 474 and 388. On May 7 the comet was somewhat brighter, and two spectra were taken on different types of plate. From these it was seen that the continuous spectrum extended at least from λ660 to 395. Bands were present at 568, 516, 474, and 388, the latter very feeble. C. P. B.

1087. *Spectra of Comets.* **A. Fowler.** (Roy. Astronom. Soc., M.N. 70. pp. 484–496, April, 1910.)—In a former paper [Abstract No. 367 (1910)] it was shown that the previously unknown bands which appeared in the spectra of comets Daniel and Morehouse were formed in the spectra of carbon compounds at extremely low pressures. Further work was undertaken to ascertain the precise carbon compound producing the special tail spectrum, to extend the investigation into the green and ultra-violet, and to determine the general relation of the new spectrum to the series of bands recorded by Deslandres [Abstract No. 1206 (1905)]. Spectrum tubes about 0·75 in. diam. were employed, with spark-length of 3 in., the spectrum being viewed through a quartz window attached to the tube with sodium silicate. With ordinary pressures the spectrum was observed as due to nitrogen, then after continued sparking at lower pressures, the CO bands (561, 519, 483) appeared; at the lowest stages of luminosity the tail spectrum was observed to become predominant. Similar experiments with CO_2, petroleum, benzene, CS_2, and cyanogen showed that the spectrum was only produced by an oxide of carbon and most probably the monoxide CO. Using a wide tube the tail spectrum began to appear on the kathode at a pressure of 2–3 mm., but the bands were not visible at the anode with this pressure. At lower pressures, however, they appear in all parts of the tube along with negative pole bands. Very good results were obtained by means of a hot lime kathode, but apart from this it has not been possible to produce a bright source of the tail spectrum. For a long time the spectrum of Brodsen's comet as observed by Huggins in 1868 has been regarded as abnormal, the chief maxima being considerably displaced with respect to the Swan carbon spectrum. If we regard them as the equivalents of the three bands of the new tail spectrum in the visual region the discrepancy would disappear. A new series of 8 bands appearing at high pressures (100 m.) in the CO spectrum is also described and illustrated. There appears to be evidence of their occurrence in certain comet spectra, *e.g.*, Borelly's Comet 1908 and Comet 1910*a*. In the light of this new work it is considered doubtful if the Swan spectrum of carbon is characteristic of comet tail spectra, as has so long been accepted. Carbon monoxide is suggested as the most abundant constituent. When the gas is of sufficient density it readily yields the Swan spectrum, which is the chief feature of the comet head spectrum. If there be a small admixture of nitrogen, the cyanogen bands at 3884 and 4216 appear quite strongly if the gas be dense, but not if only at low pressure. The true characteristic hydrocarbon band at λ431 is only occasionally present. It is a curious feature that the ordinary CO_2 bands recorded by Ångström at 561, 519 have not yet been recorded in comet spectra. C. P. B.

1088. *Altitude of Aurora.* **C. Störmer.** (Comptes Rendus, 150. pp. 1681–1684, June 13, 1910.)—One of the chief difficulties in observations of the aurora is owing to the continual movement of the luminosity, rendering measurements of its height, &c., somewhat uncertain. Recent experiments have been made with a cinematograph objective of 25 mm. aperture and focal length 50 mm., using Lumière violet label plates. In Feb. and March, 1910, an expedition was made to Bosekop, when 800 photographs of aurora were made, the times of exposure varying from 1–20 sec., depending on the brilliancy of the phenomenon. By arranging similar observations at two stations connected by telephone, it is hoped to secure a series of simultaneous photographs which will furnish measures for determining the height of the aurora. Preliminary exposures indicate 50–190 km. C. P. B.

1089. *Heliodynamic Theory of Aurora Borealis.* **de Kérillis.** (Comptes Rendus, 150. pp. 1296–1299, May 23, 1910.)—The auroral display takes the form of luminous arcs having as pole approximately the position 81° N. and 97° W., about midway between the magnetic and geographical poles. Consider these regions to be occupied with auroral matter, itself non-luminous, as layers of isostatic equilibrium. In this case the two chief factors in producing change would be terrestrial magnetism and solar action. If the solar action is chiefly radially directive the auroral displays would be periodic, depending on the passage of the auroral circle through the region opposite to the sun. The existing records are examined from this point of view, and a considerable number of points of agreement are presented. C. P. B.

1090. *Evolutionary Classification of Stars.* **J. C. Kapteyn.** (Astrophys. Journ. 31. pp. 258–269, April, 1910.)—Evidence is given to show the probable increase of radial velocity as the spectral type departs from that of the helium stars, which were found by Frost and Adams to have peculiarly low velocities in the line of sight. It is also found that there is a definite relation between the length of period of binary systems and their spectral type. In Dyson's second paper on the systematic motion of the stars it is shown that stars of Type I diverge less from the general drift than the other stars, so that it appears the phenomena of star-streaming shows itself in greater purity for the younger spectral types than for the older ones. It is suggested that for the further study of this question it is desirable to investigate separately the spectral classes of the stars composing the two star streams. C. P. B.

1091. *Origin of Binary Stars.* **H. W. Russell.** (Astrophys. Journ. 31. pp. 185–207, April, 1910.)—The fission theory is shown to be most in agreement with the facts found from observation of existing multiple systems. An analytical discussion is given of the conditions governing certain stages of separation and their similarity to known systems. For such a distribution of masses as is found among binary stars, multiple systems of this type must be pairs, one or both of whose components are themselves double, with a distance less than about one-fifth that of the wide pair. The observation of such systems is complicated, however, by the difficulty of deciding whether an apparent double star is an optical or physical binary if the period is very long. In the case of star clusters it appears that the "separate nuclei" development is the more probable course of evolution. C. P. B.

1092. *Star Colours.* **L. Bell.** (Astrophys. Journ. 31. pp. 234–257, April, 1910.)—The paper gives the results of an attempt to discover the relation, if any, between the visible colours of the stars with the known facts regarding their spectra, and the varied series of tints recorded by many double-star observers. It is noteworthy that visual observations of isolated stars are less prolific in pronounced colour record than those of double stars. A very casual study proves that there are no extraordinary colours among the most prominent stars, or in fact any which approximate in tint to the more refrangible portions of the spectrum. Careful analysis of the Potsdam colours with the spectra obtained at Harvard College Observatory shows that these very different systems are in practical agreement. One peculiarity is that in every case of a double star where one component is described as blue, that is invariably the smaller star. Moreover, most doubles having bluish companions have a conspicuously greater difference in magnitude than doubles of the same colour, and the former have a large proportion of yellow primaries; it is also found that binary stars show no greater tendency toward such colouration of the companions than do double stars in general. From this it is argued that all the colours observed in double stars are of purely subjective origin from contrast effect. An extension of the inquiry to the cases of variations in stellar colours is proceeding. C. P. B.

1093. *Accuracy of Radial Velocity Measurements.* **E. B. Frost.** (Astrophys. Journ. 31. pp. 377–381, May, 1910.)—So many statements have been made of recent years claiming high degree of accuracy for radial velocity determinations that the author feels that an authoritative statement from one actively engaged in the work is timely. He thinks it only just possible that the velocity of any star is known to the nearest kilometre. Indeed, measures of the same spectrum by different observers often result in discrepancies amounting to 1 or even 2 km. Taking a high-grade determination of Arcturus with a three-prism spectrograph, the uncertainty may attain to 1·5 km., and with less powerful one-prism instruments this error may easily amount to more than 5 km. The author then points out how very much greater uncertainty must occur with prismatic camera determinations, and thinks the estimate made by Pickering [see next Abstract] far too sanguine. To depend on a single comparison line is very unsatisfactory; even with three good lines it would be contrary to good practice to state any velocity if determined from a comparison line more than a few tenth-metres away. Further, in the objective-prism method one of its chief characteristics is that it shows many spectra at the same exposure, and as a certain number of these must be at varying distances from the axis, distortion will occur and the scale value will be widely different for different stars. The writer is doubtful if results nearer than about 25 km. per sec. will be possible with the objective prism spectrographs at present available. C. P. B.

1094. *Absolute Wave-length Determination with Objective Prism.* **E. C. Pickering.** (Astrophys. Journ. 31. pp. 372–376, May, 1910.)—In collaboration with R. W. Wood the author has recently experimented with an absorption filter of neodymium chloride, and it is probable that the velocities may by its means be found to within 10 km. per sec. The chief line is quite sharp and near λ4272, and when this is registered on each plate the measures from it and two other stellar lines will give the velocity. C. P. B.

REFERENCES.

1095. *Radius of Sphere of Action of a Molecule.* **R. D. Kleeman.** (Phil. Mag. 19. pp. 840–846, June, 1910.)—A mathematical investigation, the object of which is to give a definite expression for the radius of sphere of action in terms of other quantities. E. M.

1096. *Distribution of Mean Annual Rainfall of the Counties near Dublin.* **W. J. Lyons.** (Roy. Dublin Soc., Proc. 12. 32. pp. 354–373, May, 1910.)

1097. *Spectra of Major Planets.* **V. M. Slipher.** (Lowell Observatory, Bull. No. 42. Nature, 83. p. 232, April 21, 1910. Abstract.)—The photographs of the planets were taken on panchromatic plates, and extend up to the line A of the solar spectrum. Comparisons between the various spectra indicate that the bands seen in Mars, Jupiter, and Saturn are much intensified in Neptune. C. P. B.

1098. *Halley's Comet and Atmospheric Gases.* **G. Claude.** (Comptes Rendus, 150. pp. 1311–1312, May 23, 1910. Annal. Chim. Phys. 20. pp. 573–574, Aug., 1910.)—Analyses of atmospheric air on May 17, 19, 20, and 23 showed no appreciable variation in the composition of the atmosphere so far as the inert and more permanent gases (N, Ne, He, H) are concerned. A. D. R.

1099. *Earthquake Epicentres.* **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 11–16, June 23, 1910.)—Working with the Wiechert seismograph it was found that the azimuth of the epicentre could be determined from the two components of the ground motion, and the method adopted has been tested by an investigation of all the important earthquakes of 1909. The calculated and true values are tabulated and show a very convincing agreement. C. P. B.

1100. *Refraction and Solar Phenomena.* **J. A. Anderson.** (Astrophys. Journ. 31. pp. 166–170, March, 1910.)—After examining the possible distortion of rays proceeding from various parts of the solar surface by passage through the intervening vapours, it is concluded that they are too minute to be detected by the optical means at present available, and that anomalous dispersion, although probably in action, cannot to any appreciable extent account for the characteristic solar phenomena. C. P. B.

1101. *Theory of Star Place Reduction.* **L. de Ball.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1237–1279, Oct., 1909.)—Analytical outline of the theory for determination of star places on astrographic photographs, or from heliometer co-ordinates. C. P. B.

LIGHT.

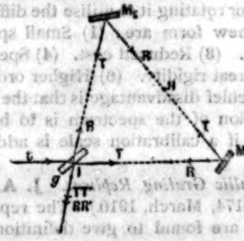
1102. *New Mounting for Concave Grating.* **A. Eagle.** (Astrophys. Journ. 31. pp. 120–142, March, 1910.)—To avoid several disadvantages of the standard Rowland mounting for concave gratings the Littrow form of mounting is suggested, and a detailed description given of an instrument fitted up in this manner. The grating is so tilted that the diffracted beam is returned to the camera along the line of the incident beam, a slight tilt being given to the grating to allow of the insertion of the photographic plate, which is inclined at an angle equal to that of the light incident on the grating surface. Provision is made for varying the distance of grating from the slit and camera, and for rotating it to utilise the different orders of spectra. The advantages of the new form are: (1) Small space occupied. (2) No darkened room necessary. (3) Reduced cost. (4) Spectra either side normal equally accessible. (5) Great rigidity. (6) Higher orders available than with ordinary mounting. The chief disadvantage is that the focus must be changed whenever a different region of the spectrum is to be examined, but much of this may be obviated if a calibration scale is added. C. P. B.

1103. *Glass and Metallic Grating Replicas.* **J. A. Anderson.** (Astrophys. Journ. 31. pp. 171–174, March, 1910.)—The replica gratings made by taking casts in celluloid are found to give definition comparable with the original when of small dimensions, the shrinkage during drying producing distortion. By introducing certain gums into the celluloid solution and heating the replica it is possible to produce a positive replica of the original grating. This may then be coated with Pt, Ni, or Au by kathode deposition, or etched with hydrofluoric acid when wanted on glass or quartz. [See also Abstracts Nos. 112 (1906); 999 (1907); 1868 (1909).] C. P. B.

1104. *Photographic Evidence for Dispersion of Light in Space.* **H. E. Ives.** (Phys. Rev. 30. pp. 272–273, Feb., 1910. Abstract of paper read before the Amer. Physical Soc., Dec., 1909.)—It was found by Tikhoff [Abstract No. 624 (1909)] that when photographed through coloured glasses faint stars were more distinct on the negatives taken with light of longer wave-length, and he urged from this that there was a scattering or dispersion of light in space. Now it is pointed out that the scale of gradation of a photographic plate may be very different for lights of different wave-lengths. It is known that a "red" image develops up slower than a "blue" image, although both may finally attain the same density, and, further, the sensitive layer obtained by bathing plates in dyes is very thin. Laboratory tests of exposures through red and blue screens were made, and exhibited many of the phenomena shown by the star photographs, so that the dispersion of light in space cannot yet be regarded as satisfactorily demonstrated. C. P. B.

1105. *Photographic Phenomena and Dispersion of Light in Space.* **H. E. Ives.** (Astrophys. Journ. 31. pp. 157–165, March, 1910.)—Certain photographs obtained by Tikhoff [Abstract No. 624 (1909)] have been interpreted as evidence for dispersion of light in space, but it has been shown by Parkhurst [Abstract No. 1853 (1909)] that variations of the magnitude found by Tikhoff may easily be produced by the departure of the actual behaviour of photographic plate and colour filter from the theoretical Schwarzschild equation, as Tikhoff assumed that the scale of gradation was constant for all colours. In the present paper the author describes two possible sources of difference : (1) The fact that with certain developers an image obtained through a red glass develops slower than one through a blue glass, although the final density may be the same. (2) In a plate sensitised by bathing the sensitive layer is very thin. [See preceding Abstract.] C. P. B.

1106. *Interference of Two Beams which have described the same Circuit in Opposite Directions.* **G. Sagnac.** (Comptes Rendus, 150. pp. 1302–1305, May 23, 1910.)—Of the beam emerging from the collimator C (see Fig.) one part is reflected, and describes the path IM_2M_1I, the other passing round the same circuit in the opposite direction. The two beams combine at TT′, RR′, and are collected by a lens. The length of the circuit was 30 m. The bands obtained by this form of interferometer are described, and are from 1 to 2 mm. apart. G. E. A.



1107. *Size of Particles in Comets' Tails and their Light-scattering Effect.* **J. W. Nicholson.** (Phil. Mag. 19. pp. 626–630, April, 1910.)—Various opinions have been held as to the probable degree of aggregation of molecules in the tails of comets. That the majority of the particles are not of molecular size, in spite of the probable tenuity of the gases in the tail, now seems to be fairly certain. The theory of radiation-pressure proposed in general terms by Arrhenius, and examined later by Schwarzschild from a strictly mathematical standpoint, demands, if it is to give a description of the phenomena associated with the tails of the most difficult type, the existence of particles of such a size that the pressure of solar radiation on a single particle must be about nineteen times as great as the solar gravitation. The present author by different analysis has substantially confirmed the results of Schwarzschild. It thus appears that on a radiation-pressure theory of the tails, particles must be present whose dimensions are comparable with the wave-length of light, and these must consist of aggregates of a very large number of molecules. In view of the low pressure at any point of the tail, a necessity appears to arise for the presence of a large number of particles of much greater size, which by continuous disintegration give rise to a sufficient number of the dimensions proper for a maximum radiation pressure.

E. H. B.

1108. *Radiation Pressure on Reflecting Spherules.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 70. pp. 544–565, May, 1910.)—Since the suggestion has been revived by Arrhenius that the force of repulsion from the sun, which is necessary to a description of the phenomena associated with the tails of comets, might be caused by the pressure exerted upon the particles of the tails by the incident solar radiation, much discussion has taken place as to the possibility of a force of sufficient magnitude being exerted in this manner. The only mathematical analysis of the question, from a formal standpoint has been given by Schwarzschild, who has found that a force of the magnitude required in the case of the tails of the most difficult type (about 18·5 times the solar gravitation) could just be obtained if the size of the particles in the tail were of the same order of dimension as the mean wave-length of the incident light, and if they were perfectly reflecting. This is, of course, the case in which the pressure is a maximum, and the fact that it would need to be attained for a very large number of the particles appears to indicate that a majority of these are of the particular dimension required, and, moreover, totally reflecting. This is a very decisive result, and it is obvious that its foundations must be strictly tested. It could be avoided if the maximum were somewhat larger, or if the rise and fall of the radiation-pressure towards and away from its max. value were not very sharp, so that the range of size for an approximate maximum would be extensive. Both these possibilities are negatived by the numerical results which Schwarzschild gives, but these are few in number, and the whole question appears to demand further treatment. The analysis of Schwarzschild is long and complicated, and the present author sets out to corroborate it by a different analysis, in many respects simpler and more direct. The main conclusion of the present paper is a support of the theory in general, and the maximum is shown to be larger (22 instead of 18). Moreover, the fall of pressure from the maximum, as the size of the particles increases, is by no means so rapid as that obtained by Schwarzschild. The theory is therefore strengthened in two distinct ways. [See also preceding Abstract.] E. H. B.

1109. *Line Spectrum of the Electric Arc.* **A. Occhialini.** (N. Cimento, 19. pp. 811–817, May, 1910.)—Observations of the spectrum of the electric arc, obtained by projecting the image of the arc upon the slit of a spectrometer, show that it consists of bands and lines, the former being limited to the neighbourhood of the anode, and the lines having a max. intensity near the kathode. The arc at the moment of its production emits a line spectrum throughout its entire length, and all the lines observed near the kathode in the arc when once established are found also along the whole length of the arc in its preparatory phase. These results are in accord with the author's previously published views [Abstracts Nos. 1487, 1588 (1909)] as to the constitution of the electric arc. The line spectrum is always different from that of the spark, whatever the conditions of p.d. and capacity, though increase of the latter produces an arc very similar to a spark. W. H. Si.

REFERENCE.

1110. *Determination of the Constant of a Distance-measuring Telescope.* **N. Jadanza.** (Accad. Sci. Torino, Atti, 45. 9. and 10. pp. 815–820, 1909–1910.)—A method is described for measuring the constant of a distance-measuring telescope, and is then applied to a Simms tacheometer, the results obtained agreeing closely with specification. W. H. Si.

HEAT.

1111. *Coefficient of Expansion of Nickel near its Critical Temperature.* **W. F. Colby.** (Phys. Rev. 30. pp. 506–521, April, 1910.)—In 1901 Holborn and Day measured the expansion of nickel and found that at 300° the coefficient undergoes a change. Harrison, working on a nickel wire under tension, found that it underwent an anomalous expansion at 370°, the critical temperature of the specimen. Working with a solid cylinder of the metal and using a Pulfrich interferometer, Randall has recently found that the coefficient increases steadily till about 275°, and from that temperature till about 400° remains practically constant. The specimen he used lost its magnetism at 310°. On account of the disagreement in the above results the present author has taken up the work and has investigated three specimens of the metal. Two rings and one short cylinder were observed when magnetised under a constant force at different temperatures, measured by an iron-constantan thermometer. An electrolytically prepared specimen showed a high value of permeability just below its critical temperature [370°]. The other specimens, which were not pure, had a lower critical temperature. It was also found that (1) the absolute value of the expansion coefficient is in part dependent on the history of the specimen; (2) through a continuous heating the relative values show an increase at the beginning of the region, followed by a decrease; (3) before and after the critical regions, the coefficient increases at a regular rate. W. C. S. P.

1112. *New Method of determining Thermal Conductivities.* **H. R. Nettleton.** (Phil. Mag. 19. pp. 587–596, April, 1910. Paper read before the Physical Soc., Feb. 25, 1910.)—A. Griffiths has obtained an expression for the concentration of a solution in a vertical tube in which there is both movement of the solution and diffusion of the solute. The present author has now obtained a similar expression in the case of thermal diffusion. He considers a bar moving longitudinally at velocity v through two constant temperature sources, and shows that the conductivity is given by $K = \frac{1}{2} v\rho s \, L/\log_e(-\theta_2/\theta_1)$, where ρ is the density, s the specific heat, and L the length of the bar, and θ_1, θ_2 the temperatures at any two points in the bar at equal distances from the point in the bar where the temperature is the same as the surroundings. The ratio of these two temperatures is thus independent of the emissivity. The above formula is then applied to determine the conductivity of mercury. From an iron reservoir heated by means of steam, the mercury is allowed to flow down a vertical glass tube 3 cm. diam. into a second reservoir, which is maintained at 0° C. After about 3 hours the temperature gradient of the mercury, as indicated by a number of thermometers, becomes steady, and the weight flowing out in 15 min. is determined. There is an automatic tendency for the flow to be constant. Curves are plotted showing the relation between the temperatures and the distances for various rates of flow, and the values of θ_1, θ_2 estimated at equal distances left and right of the point at which the temperature is the same as that of the room. From these experiments he finds $K = 0{\cdot}0209$, the various numbers differing by about 1 per cent. W. C. S. P.

1113. *Heat Capacity of Metals and Metallic Compounds.* **H. Schimpff.** (Zeitschr. Phys. Chem. 71. 3. pp. 257–300, Feb. 4, 1910.)—The heat capacities of 15 pure metals and 29 metal compounds have been determined by the method of mixtures in the three temperature-intervals 17° to 100° C., 17° to −79° C., and 17° to −190° C., and the results agree very closely with those of previous workers and with the calculated values of the specific heats. Between +50° and −150° C. the temperature coefficient of specific heat decreases with rising temperature for both metals and the inter-metallic compounds, except in the cases of Pb and Bi. In most cases the difference between the observed and calculated values of the specific heats of the inter-metallic compounds lies within 4 per cent. Kopp's law of mixtures can therefore only be regarded as an approximation in the case of alloys. The observed specific heats of Mg alloys are lower, and those of Sb alloys higher, than the calculated values. The atomic heats of metals increase with increasing temperature, and similar remarks apply to the compounds. F. C. A. H. L.

1114. *Radial-Flow Porous Plug and Calorimeter.* **E. S. Burnett** and **J. R. Roebuck.** (Phys. Rev. 30. pp. 529–531, April, 1910.)—A description of a porous plug and calorimeter in which the errors due to conduction and radiation between the fluid and its surroundings, and between the temperature-measuring devices and their surroundings are reduced to a minimum. The fluid is first brought to any desired initial temperature, and maintained there by passing through a coil immersed in a bath controlled by a thermostat. After passing through the coil its temperature is measured by a thermometer. It then passes into a radial-flow portion which is situated in the bath but thermally insulated from it. This portion in the case of the porous plug consists of a round-ended porous tube of porcelain, and the fluid passes through radially. In calorimetry, instead of the porous plug there are two concentric tubes that offer no resistance to the flow of the fluid, which is electrically heated as it crosses the space between them. The fluid flows radially through these tubes, and is then led away through a passage insulated from the bath. If the fluid passes through the porous partition with a rise of temperature, the conduction of heat by the porous partition is opposed to the flow of fluid, and only very small flows would be necessary to completely off-set this minute conduction. Thus both outer and inner surfaces of the plug would be exactly at the temperature of the fluid. If there is a fall of temperature, then on account of the poor conductivity of the porous material and the intimate contact of the fluid with the wall, the errors due to radiation are negligible. W. C. S. P.

1115. *Emissions from Incandescent Bodies.* **E. Brunè.** (N. Cimento, 19. pp. 177–181, March–April, 1910. Abstract of paper read before the Soc. Italiana di Fisica, Sept., 1909.)—Experiments with the carbon filament of an ordinary incandescent lamp show that when the filament is heated to an orange-red colour it attracts a negatively charged body; that as the temperature is further raised it passes through a state when there is no sign of electrification; and that at a white heat it attracts a positively charged body. This inversion of sign is not dependent only on the temperature. Using a Pt filament enclosed in a glass tube connected with a mercury pump, the author has verified that at the ordinary pressure, raising the temperature rapidly from red heat to the max. heat attainable with Pt-wire, increases the emission of positive ions; under slightly reduced pressure, on the other hand, there is a diminution of electric charge, and as the pressure is further reduced, inversion of the sign of electrification takes place, and finally there is a preponderance of electrons. These phenomena may be explained by assuming that a gas adheres to, or is occluded by, the filaments, and being liberated when the filament is heated, its particles come in contact with electrons emitted by the incandescent filaments, thus giving rise to positive ions. As the temperature rises this gas expands, the increase of pressure causing the inversion of electric sign. Further experiments will be conducted to determine whether the phenomena are independent of the nature of the filament itself, or in what way they depend upon it. W. H. St.

1116. *Saturation Pressure of Water-vapour between* 0° *and* 50°. **K. Scheel** and **W. Heuse.** (Ann. d. Physik, 31. 4. pp. 715–736, March 15, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—The statical method was employed, the water being placed in two tubular glass flasks: the pressure of the vapour in both flasks was compared with that in a flask which was immersed in a mixture of solid CO_2 and alcohol. For the measurements at temperatures below that of the room the two flasks were immersed in a water bath, the temperature of which could be regulated by means of a stream of ice-cold water. At higher temperatures a paraffin oil bath surrounded by a vacuum was used, and its temperature was varied by means of a heating coil which was part of the stirring apparatus. Two manometers were used, one having a range of 30 mm., and the second for pressures up to 90 mm. The first is similar in construction to that used by Raleigh in his work on the application of Boyle's Law at low pressures. The second manometer consisted essentially of a U-tube containing mercury, and having a vacuum on one side, the other side being connected to the pressure to be measured. This manometer was maintained at a temperature of about 56° by placing it in a bath, through the double walls of which circulated the vapour of acetone. The temperature was measured by means of a Pt thermometer. For the discussion and comparison of their results with those of Holborn and Henning, and also with those obtained from the formula of Thiesen, the original should be consulted. [See also Abstracts Nos. 1025 (1907), 1646 (1908), 1715 (1909).] W. C. S. P.

SOUND.

1117. *Sound Measurer.* **F. R. Watson.** (Phys. Rev. 30. pp. 471–478, April, 1910.)—This apparatus was devised to measure quantitatively the intensity of sound in auditoriums. It consists essentially of a telephone receiver in series with a thermo-galvanometer having a heating wire of 94·8 ohms, a 1 mfd. condenser being in the same circuit. A resonator was also mounted on the telephone plate and adjusted to resonance with the sound in use. Maxima and minima of sound were easily detected in a small laboratory, and quantitative results were obtained which could be repeated. E. H. B.

1118. *New Sound Recorder.* **T. Rosset.** (Comptes Rendus, 150. pp. 1511–1513, June 6, 1910.)—Describes an arrangement by which two cylinders revolve together and while one cylinder of *wax* is being graved by one sapphire to form a phonographic record, the other cylinder receives a trace on its surface from a second sapphire coupled to the first, and thus forms a visible and legible record of the sound in question. The latter record may also be photographically reproduced. E. H. B.

1119. *König's Theory of Ripple Formation in Kundt's Tube.* **J. Robinson.** (Phil. Mag. 19. pp. 476–485, April, 1910.)—Referring to previous experiments which were in fair agreement with König's theory as to the ripple formation [see Abstract No. 1905 (1909)], the author now develops the theory by extending it to the case in which the velocities concerned are different (w_1 and w_2) instead of each the same (w_0). It is then shown that the change in the result is simply the substitution of w_1w_2 for w_0^2. Comparing this more refined theory with the experimental results a good quantitative agreement is found. E. H. B.

1120. *Photographic Record of Fork Vibrations.* **G. Sizes** and **G. Massol.** (Comptes Rendus, 150. pp. 1746–1747, June 27, 1910.)—The study of the many sounds emitted by a fork, and particularly of the *grave* harmonics made by the aid of a wire, seemed to need a check by other methods. The present work substitutes the photographic record of the motion by means of the beam reflected from a small mirror on one prong, the other being balanced by a body of equal mass. For this fork, ut_0 of 32 vibrations, some of the previously found tones are confirmed by the new method and others found. The series now obtained by photography has the number of vibrations following: $\frac{1}{3}$, 1, $1\frac{1}{3}$, 2, $2\frac{1}{3}$, 4, $4\frac{2}{3}$, 7, 8, 16, $18\frac{2}{3}$, 28, 30, 32, 36, 56, 60, 64, 192, 200, 214, 360, 512, 560. With the above series the fork in question has thus yielded 64 different tones up to date. [See Abstracts Nos. 89 and 646 (1908) and 1422 (1909).] E. H. B.

REFERENCE.

1121. *Acoustic Quality.* **J. Delemer.** (Annal. Soc. Sci. de Bruxelles, 34. 2. pp. 149–163, 1909–1910.)—Discusses the Helmholtz-Ohm theory of the quality of musical and other sounds, and points out a number of cases in which the partial tones possible are inharmonic and so do not form a Fourier series. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1122. *Electrostatic Effect of a Changing Magnetic Field.* **J. M. Kuehne.** (Phil. Mag. 19. pp. 461–476, April, 1910.)—In the development of Maxwell's electromagnetic theory there is implied, if not directly expressed, the existence of four distinct mutual effects between electrostatic and magnetic phenomena, some of which have to this day eluded experimental verification. While it may not be said that the value of the theory depends to any very serious extent upon the demonstrability of these assumed effects, yet a great theoretical interest attaches to the question whether the foundations of this theory, which has shown such phenomenal fruitfulness in directing research, can be experimentally established. The four assumed effects are: (1) A moving electric charge produces a magnetic field. (2) A moving magnetic pole produces an electric field. (3) A changing electric field produces a magnetic field. (4) A changing magnetic field produces an electric field. In all four cases the difficulty in the way of experimental verification lies in the extreme smallness of the force which is finally to be observed and measured, together with the comparatively very large disturbing forces which must come into play when electric charges and magnetic fields of sufficient magnitude are used to make the effect sought for at all observable. This is shown at once by the fact that in the denominator of the formula in each case there enters the well-known *v* of Maxwell. Of these four effects the first was demonstrated by Rowland in 1876, the third by Eichenwald in 1903. The converse effects (2) and (4) have, so far, resisted all attempts at experimental proof. The attempts of Lodge in 1889, of Crémieu in 1900, and of Whitehead in 1905, are then discussed, and the author's first method described, which could not, however, yield a decisive result. The successful method finally adopted comprises a parallel plate condenser, of which one conductor is built up of 20 rings of thin varnished cardboard, which alternate with the 21 rings forming the other conductor. One conductor is stationary, the other can rotate about the vertical axis common to all the rings. Passing through the centre of these rings is the iron core which forms one limb of an electromagnet, the current used being from an e.m.f. of 110 volts, which is 60-∿ alternating. The condenser is charged alternately, so that the charging e.m.f. is very nearly 90° out of phase with the magnetic field. The theory is then given and the moments to be looked for calculated. The observed moments show a decided tendency towards lower values than the calculated amount. The experiment as it stands shows that a charged body in a changing magnetic field, or perhaps more exactly in a field swept by magnetic lines of force, is subjected to a mechanical force the magnitude and direction of which are in agreement with those demanded by the electromagnetic theory of Maxwell.

E. H. B.

1123. *Effect of Dust and Smoke on Ionisation of Air.* **A. S. Eve.** (Phil. Mag. 19. pp. 657–673, May, 1910.)—Many observers [see Abstract No. 1765 (1905)] using the instrument, or ion counter, of Ebert, have found a considerable excess of positive over negative ions in the atmosphere. This large excess appears remarkable, and in the present investigation an explanation has been aimed at. Air ionised by γ-rays from Ra was passed through an Ebert instrument, and it was found that about 20 per cent. more positive than negative ions could be collected, and that this excess was little influenced by causing the ionised air to pass through meshed gauzes so as to increase diffusion effects. The number of ions detected was found to depend largely on the purity of the air as regards dust, smoke, mist, or other centres, varying as much as 50 per cent. Further investigations showed that these effects are largely due to both kinds of small ions, particularly the negative, rapidly combining with particles of dust, &c., and passing through the testing vessel undetected. These large smoke ions have feeble mobility, and recombine slowly, and a strong electric force is required to detect them. The author discusses the bearing of the various results on the number of ions found in the air over the sea, and also on the variations of the potential gradient found in the atmosphere. E. M.

DISCHARGE AND OSCILLATIONS.

1124. *Connection between Faraday's Law and Discharge through Gases.* **A. Wehnelt** and **J. Franck.** (Deutsch. Phys. Gesell., Verh. 12. 10. pp. 444–456, May 30, 1910.)—The experimental arrangements are based upon the known difference of mass of the anion and the kathion under suitable conditions. If the pressure is sufficiently low the negative carriers are electrons, while the positive are atoms or molecules, so that there must result a transport of gas from the anode to the kathode. This must bring about a decrease in pressure at the former, and an increase in pressure at the latter. In order to make it more difficult for the pressures to equalise in the tube, the anodic region communicates with the kathodic region by means of a fine capillary tube. It is found much more convenient to measure the alteration of pressure at the anode, so the kathode space is made very large in proportion to the anode space. The apparatus used is described by the aid of a diagram. An equation is established by means of which the number of molecules transported can be calculated. It is found that when a current of 1 amp. flows for 1 sec. the number of gas molecules transported from the anode space is $0{\cdot}815 \times 10^{18}$. Within certain limits this is independent of the gas pressure, and, so far as at present investigated, of the material of the electrode also. It is, further, independent of the nature of the contained gas. The lowering of the pressure at the anode is proportional to the current strength. Assuming the validity of Faraday's law, this gives for the present research that ¼ of the ions are formed in the neighbourhood of the anode and ¾ of the ionisation takes place at the kathode. The influence of absorption and the sources of error are fully discussed. A. E. G.

1125. *Mutual Action of Two Kathodes in a Magnetic Field.* **Gouy.** (Comptes Rendus, 150. pp. 1652–1655, June 20, 1910.)—The experiments are so arranged that phenomena occurring when lines of magnetic force extend from one kathode to the other can be studied: this is called by the author the "privileged" position. It is well known that the explosive potential increases enormously as the vacuum is pushed very high. The action of the magnetic field if acting at right angles to the "privileged" position, increases this potential still further. When acting in the "privileged" position the potential required is, however, hardly above 400 volts. Thus a current is obtained with 500 volts when under ordinary circumstances 20,000 volts would be required. When the current passes with the tube in the "privileged" position the magneto-kathodic bundles are superposed, and the inter-kathodic space is brightly illumined. There is, however, near each of the kathodes a relatively dark space, which is so much the more limited as the electric oscillations in the tube are the more intense. If one of the kathodes is insulated there is the same inter-kathodic light, but the dark space on the side of this kathode is either entirely wanting or only very small. The same occurs if the secondary kathode is replaced by an insulated rod, and it is even the same on the glass walls of the bulb. The glass walls when acting as a secondary kathode produce, although to a less degree, the same lowering of explosive potential as an ordinary kathode. Thus a bulb with a single kathode may allow a current to pass when the lines of magnetic force passing from the kathode meet the glass walls, and may stop this current when these lines of force meet the anode. A. E. G.

1126. *Formation of Kathodic Deposits.* **L. Houllevigue.** (Comptes Rendus, 150. pp. 1683–1684, June 20, 1910.)—A number of experiments are described, all of which show that the deposition only takes place on surfaces possessing a positive charge, which neutralises the negative charge of the kathode granules, thus confirming the analogy between colloidal granules and the particles projected by a kathode [Abstract No. 968 (1910)]. W. H. Sl.

1127. *Electric Arc Hysteresis.* **G. Lange.** (Ann. d. Physik, 32. 3. pp. 589–647, June 2, 1910. Extract of Dissertation, Göttingen, 1909.)—The paper gives the results of experiments conducted to substantiate Simon's theory of the alternating-current arc [see Abstract No. 1465 (1905)]. The experiments, which are carried out with carbon electrodes, investigate the influence of (1) thickness of carbons, (2) gas surrounding arc, (3) length of arc, (4) self-induction in arc circuit, (5) magnetic field on arc, (6) pressure of gas. The characteristics were obtained by simultaneous observations of current and voltage by oscillograms. The results obtained on the points mentioned are: (1) The conduction of heat away from the arc is a maximum when the diam. of the carbon is 6 mm. (2) The series—nitrogen, air, carbon dioxide, enclosed arc, hydrogen—gives higher "striking" potential, as we pass down it: while the series—nitrogen, carbon dioxide, air, enclosed arc, hydrogen—gives higher potentials for the point in the hysteresis curve where the current is a maximum. (4) A self-induction in the arc circuit causes a much steadier arc and greater intensity of light. (5) The magnetic field raises the whole characteristic. As the strength of field is increased, periodical variations of the potential during each half-period become evident, due to the fact that the arc path is driven to the side and ruptured while a new arc is struck across the shortest path. The effect of the magnetic field varies with the gas. It is smallest with air or nitrogen, and greatest with hydrogen. If, however, great field strengths are used, CO_2 is found to be even more sensitive than hydrogen. (6) In the experiments under diminished pressure the changes in the discharge as it passes from the glow-discharge to the arc-discharge are described. The latter part of the paper is devoted to a discussion as to how far Simon's theory of the arc can be quantitatively applied to experiment, and cannot be easily abstracted. The influence of arc-length is discussed. By a modification of the static characteristic, the theoretical dynamic characteristic and that found by experiment are brought into agreement. Oscillograms of current and voltage are given throughout. T. P. B.

1128. *The Mercury Arc in a Vacuum.* **A. Perot.** (Comptes Rendus, 150. pp. 1515–1517, June 6, and pp. 1684–1687, June 20, 1910.)—The mercury arc was studied between two mercury electrodes enclosed in a spherical glass bulb of about 12 cm. diam. at various very low pressures. At very high vacua the whole bulb is filled with white light, but when it warms up we have simply a band of white light between the electrodes. Some of the mercury is carried from the anode to the kathode. The presence of water-vapour in the bulb produces some curious effects. The movement of the luminous centres was studied spectroscopically, and by applying the Döppler-Fizeau principle a displacement in the direction of the current, *i.e.*, from anode to kathode, was noted. The velocities measured are very small compared with those usually found in vacuum tubes. For instance, when the gauge pressure was 7 mm. the velocity was only 32 m. per sec. In the second paper the author measures the drop of the potential along the mercury arc in a vacuous globe at various pressures. When the current was between 3 and 4 amps. the p.d. between the anode and the arc was 10 volts, along the arc 11 volts, and between the kathode and the arc 1 volt. If (AC) denote the voltage drop from the anode to the kathode, (AP) and (PC) the voltage drops from the anode to the middle point of the arc and from the middle point to the kathode respectively, the following results were obtained with a current of 3·1 amps. :—

Pressure in Mm.	(AC)	(AP)	(PC)	(AP)–(PC)
0·008	25	16	9	7
0·015	25·8	16·8	9	7·8
0·128	30·0	19	11	8
4·0	40·8	26	14·8	11·7
5·5	48	31	17	14

It is stated that the pressure read by the manometer was certainly less than that which existed in the arc. These numbers prove that the potential drop at the anode increases with the pressure. Further experiments show that there is a rise of gaseous pressure at the anode, this rise varying practically instantaneously with the magnitude of the current. The voltage drop at the anode is closely connected with the rise of gaseous pressure. The electric carriers are shot into the arc with a velocity of about 8 km. per sec. The action of the voltage gradient along the arc is to maintain the movement of these carriers, which are quite different from the luminous centres. The mean velocity of these carriers at different points of the arc varies very little. Both from the spectroscopic and the electric points of view the arc appears exactly the same at all points of its length. A. R.

1129. *Electric Waves through Wire Gratings.* **C. Schaefer** and **F. Reiche.** (Ann. d. Physik, 32. 3. pp. 577–588, June 2, 1910.)—Hertz found that if the electric field is parallel to the wires there is little transmission. On the other hand, Du Bois and Rubens, working with light waves, found that the transmission is greater when the electric field is parallel to the wires than when perpendicular to them, but that as the wave-length was increased, this effect gradually passed over into that observed by Hertz. Braun, using gratings prepared in a special manner [see Abstract No. 1012 (1904)], found the Hertz-effect true for light radiation. The paper gives the mathematical theory, which brings these results into line. From a consideration of the effect of a single wire it is deduced that if ρ/λ is small (ρ = radius of wire, λ = wave-length) the result obtained will be that of Hertz or Braun. When ρ/λ is great, *e.g.*, > 4, the other effect is observed. The inversion-point from one to the other is a function of ρ/λ, of the index of refraction and the coefficient of absorption of the metal of the wire. T. P. B.

1130. *Bending of Electric Waves.* **J. W. Nicholson.** (Phil. Mag. 19. pp. 516–537, April, 1910.)—The effect of an obstructing sphere on electric waves falling upon it has been expressed in a practically applicable form only in the case of small spheres. In the general case the external motion may be considered as consisting of (1) the undisturbed motion which would exist in the absence of the sphere, and (2) a secondary disturbance, zero at infinity, radiating outward from the sphere. The whole motion is then expressible in terms of an infinite series of zonal harmonics, whose coefficients involve Bessel functions and their derivatives in a complex manner. This general expression cannot be summed, and is of little use. The character of (2) is, however, determined by the ratio of the radius of the sphere to the wave-length of the incident vibration. When this is very small, as in the case of a small sphere, an approximate solution is obtainable. After reference to previous attempts, the author proceeds to develop a method of solution when the ratio is large. He first develops the harmonic series for an oscillator in the presence of a sphere, leading to a formula previously obtained by Macdonald [see Abstract No. 3240 (1904)]. According to Poincaré's criticism of Macdonald [Abstract No. 847 (1910)] the series are not shown to be convergent when the oscillator is on the surface of the sphere. The author shows that convergent series are obtainable from the formula. He then obtains an expression for the magnetic force in the region of brightness, which leads to the conclusion that the mean intensity per unit volume is quadrupled in this region, following the inverse square law from the centre of the sphere. This is in agreement with the known quadrupling effect of a perfectly opaque infinite plane. It is shown that there is no change of type in the solution near the axis. Finally, it is shown that the transitional region does not extend more than about 2° on either side of its axial plane through the oscillator. G. W. DE T.

1131. *Bending of Electric Waves round the Earth.* **J. W. Nicholson.** (Phil. Mag. 19. pp. 757–760, May, 1910.)—The author states that he has continued the examination of *residual terms* in Poincaré's investigations [see Abstract No. 847 (1910)], and has proved that they do in fact have a zero sum for points on the surface of the sphere, and play their part in the remarkable compensation of the terms of the harmonic series, so that the total effect at a point on the surface is, in fact, exponential. Poincaré's exponential factor is therefore valid for surface points, although his method does not apply to points off the surface, even though fairly close to it. Macdonald's investigation of the region of shadow [see Abstract No. 609 (1910)] is then shown to be invalid when the transmitter and receiver are near the earth, but the formula is valid for points not close to the shadow. The author also states his conclusion that the tables given for the intensity produced by diffraction round the surface ought to exhibit a very much smaller effect. G. W. DE T.

1132. *Electromagnetic Waves along Long Cylinders of Dielectric.* **D. Hondros** and **P. Debye.** (Ann. d. Physik, 32. 3. pp. 465–476, June 2, 1910.)

—A mathematical paper, which is a sequel to an earlier paper on electromagnetic waves along conducting wires [see Abstract No. 142 (1910)]. In the earlier paper it was shown that theory indicates the possibility of other waves in addition to the *one* well-known wave, only these waves are so highly damped that it is impossible to detect them experimentally. The theory is here applied, therefore, to "wires" of dielectric, where such damping would not take place, and it is shown that in this case the *one* well-known wave is wanting and the other subsidiary waves are possible. Their velocity varies with the applied frequency between the velocity peculiar to the external medium and that peculiar to the dielectric of the "wire." The results of the theory can be tested experimentally. T. P. B.

1133. *Action of Metallic Contacts on a Filings Coherer.* **B. Szilard.** (Comptes Rendus, 150. pp. 1670–1672, June 20, 1910.)—The author finds that a fillings coherer is very much more sensitive when the end of the coherer, which is earthed in the usual arrangement, is connected to one terminal of an alternating-current system, the other alternating-current terminal being connected to earth. He finds that a coherer connected in this manner is affected, when a rod of metal set up as sending antenna, is simply touched by a piece of metal held in the hand. He has obtained this action over 150 cm. The contact between the two pieces of metal must be made very lightly and between points. The metals brought into contact may be the same or different. The max. distance at which the effect is obtained depends upon the metals used. T. P. B.

1134. *Coherers.* **W. H. Eccles.** (Phil. Mag. 19. pp. 869–888, June, 1910. Paper read before the Physical Soc. Electrician, 65. pp. 724–727, Aug. 12, and pp. 772–773, Aug. 19, 1910.)—An investigation into the behaviour of an oxidised iron-mercury coherer and of an oxidised iron-iron coherer under "weak" signals, *i.e.*, signals involving energy transformations of the same order as those of wireless telegraphy. Two oscillatory circuits are set up slightly out of tune. Oscillations are produced in the primary by cutting off a p.d. which has been applied to its capacity. An interrupter giving 22 "breaks" per sec. is used. The coherer is connected, as in practice, in series with a condenser, across the capacity of the secondary circuit. The energy transmitted to it is about 0·01 erg per sec. This is determined by means of a thermo-galvanometer substituted for the coherer. The response of the coherer is represented by the sound in a telephone in its circuit. This sound is measured by comparing it with the sound in the telephone when a known current is interrupted, the energy dissipated in the telephone for any particular intensity of sound being found from observations with the thermo-galvanometer. The following results are obtained. (1) In a self-restoring coherer, as the steadily applied p.d. between the ends of the coherer is raised, the consequent current through the coherer increases more and more rapidly up to a point of inflection, after which it increases more slowly. (2) Curves are given showing how, as the applied p.d. between the ends of the coherer is increased, the energy transmitted to the telephone increases to a maximum at a particular voltage, and then gradually falls off. (3) If W represents the power in watts delivered to the coherer and w the power passed to the telephone, then $w = m(W - a)$, where m and a have values settled by the magnitude of the current through the detector. The more sensitive the coherer the greater is m. These results show that the coherer is an "integrating" detector. The author puts forward the theory that the action of these coherers depends entirely on the heating of the film of oxide by the electrical oscillations and the current due to the applied p.d. The temperature-coefficient of the oxide is negative and nearly 1 per cent. per deg. C. The theory is developed mathematically, and it is shown that all the above experimental results follow. T. P. B.

1135. *Electrical Oscillation Detector actuated solely by Resistance-temperature Variations.* **W. H. Eccles.** (Phil. Mag. 20. pp. 128–134, July, 1910. Paper read before the Physical Soc., May 27, 1910.)—This paper is a sequel to a previous paper [see preceding Abstract]. The theory of the action of certain coherers put forth in that paper is here tested by means of a specially devised detector. It is probable that, as the substances generally employed in "contact" detectors stand well apart in the thermoelectric series, the thermoelectric force plays a part in their operation. In order to avoid any thermoelectric action, a detector is made of two pieces of galena brought into gentle contact. Galena has the fairly high resistivity and large negative temperature-coefficient required by the theory. This detector is found to work excellently as a wave detector. Its action confirms the theory perfectly. The results found true of it are identical with those given previously [*loc. cit.*]. The temperature-coefficient of galena is 0·0079, that of pyrites is 0·006 per deg. C. T. P. B.

1136. *Investigation of the Barretter in Oscillatory Circuits.* **W. Kempe.** (Phys. Zeitschr. 11. pp. 331–337, April 15, 1910.)—This article is based upon the Halle Dissertations of T. Neuhaus and the present author. The sensibility of barretters made of wires of various diams. is investigated for oscillations generated (*a*) by Wien's method; (*b*) by ordinary methods with inductive coupling, and (*c*) with double (Stone) coupling. No detailed abstract is possible without reference to the numerous curves given. These relate to (1) the dependence of the sensibility upon the bridge current, (2) the relative sensibility as a function of the resistance, (3) the reaction and damping as a function of the degree of coupling, (4) the damping at various degrees of out-of-tune condition (due to inductance), (5) the damping as dependent upon the capacity. A few general results may be referred to. It is found that the damping is independent of the resistance of the barretter circuit and of the kind of barretter (size of wire). On putting the circuit out of tune by means of increased or diminished inductance, the damping of the barretter is a minimum when its circuit is in resonance with the other circuits. The total damping is independent of the amount of capacity in the barretter circuit. L. H. W.

1137. *Resistance of "Stranded" Cables for High-frequency Electrical Oscillations.* **R. Lindemann.** (Deutsch. Phys. Gesell., Verh. 11. 22. pp. 682–698, Nov. 30, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—Wire cables are carefully built up of thin wires, which are well insulated from each other. The thin wires, however, are not simply twisted together. In order to ensure that all the thin wires occupy each part of the cross-section of the cable exactly the same number of times, the cable is made by twisting together smaller cables, which again are built up of still smaller ones. The frequency employed varies from 10^5 to 10^6 per sec. The method of determining the resistance is that described in Abstract No. 528 (1909). For the lower frequency the primary circuit was excited by the arc method; for the higher frequencies by Wien's "impact" method. The increase of resistance, dR, of ideally wound cables over their resistance for continuous current is worked out theoretically, and it is shown that $dR = (2\pi^2 \iota n^2 l^2/R_0)(r/r_1)^4$, where n = frequency; l, r, R_0 = length, radius, resistance to continuous current of a single strand; r_1 = radius of a single strand, when the thickness of its insulating material is included; $\iota \leqq 0{\cdot}91$, that is, the ratio of portion of cross-section of cable filled with the wires to the total cross-section. Within the limits of experimental error, the results show the truth of the formula in so far that dR is proportional to n^2 and also to r^4 and dR is independent of the number of strands. Experiments on single wires show that, so long as the radius of the wire is not greater than 0·15 mm., dR is proportional to n^2. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1138. *Change of Resistance of Metals at different Temperatures in a Magnetic Field.* **S. C. Laws.** (Phil. Mag. 19. pp. 685–699, May, 1910.)—The substances tested were zinc, cadmium, and graphite, the first two being in the form of wire. Using a Wheatstone bridge method, the resistance of the specimens was measured with the magnetic field off and on, the wires being wound on mica frames which could be immersed in an oil bath or in a vacuum vessel for holding liquid air. Denoting by r the resistance of the specimen and δr its change of resistance in a magnetic field H, the ratio $\delta r/r$ is found to be proportional to H^2. For all three substances $\delta r/r$ increases at lower temperatures, the increase from ordinary temperature to that of liquid air being 20 times in the case of Cd and Zn, and 8 times for graphite. The change of resistance in graphite varies approximately inversely as the absolute temperature. G. E. A.

1139. *Electrical Conductivity of Liquid Metallic Alloys.* **K. Bornemann** and **P. Müller.** (Metallurgie, 7. pp. 396–402, June 22, 1910.)—Some preliminary results on the conductivity of liquid alloys are discussed. The alloys were melted in quartz tubes heated in an oil bath or a Heræus furnace, and the resistances measured by a direct determination of the e.m.f. of an electrical circuit into which the alloy was introduced. From a study of previous work on liquid amalgams, it would appear that a fundamental difference exists between liquid and solid solutions, inasmuch as the conductivity of the former appears to be greater, and that of the latter less, than those of the pure solvents, but the work of the authors shows that this is not the case. Conductivity-concentration curves were determined at different temperatures, the differences between the curves indicating the magnitude of the temperature-coefficient, which is greater in the pure metals than in the alloys. The curves for the Na-K series fall to minima, while in the Pb-Sn alloys the curves vary only very slightly from the straight lines joining the conductivities of the two metals, especially at the higher temperatures. The presence of a compound only slightly dissociated in liquid solution is clearly indicated by a maximum in the curve and is shown in the Na-K amalgams. In dilute solutions both Na and K cause a diminution of the conductivity of mercury, while other metals cause an increase. Liebenow's explana- of this fact, which is confirmed by the work of the authors, shows that mercury has a low temperature-coefficient compared with other metals, comparable with that of alloys. This is due to liquid mercury being an alloy of polyatomic molecules in a solvent of monatomic molecules. The addition of Na and K decrease the conductivity by dissolving as compounds and increasing the concentration of the polyatomic molecules, while the other metals decrease the concentration by dissolving as monatomic compounds. Heterogeneous solutions show a discontinuity in the temperature-conductivity curve at the temperature at which separation into two phases takes place. F. C. A. H. L.

1140. *Electric Properties of Aluminium-Silver Alloys.* **W. Broniewski.** (Comptes Rendus, 150. pp. 1754–1757, June 27, 1910.)—These alloys are hard, and do not possess the fragile zone common to most alloys. Their properties are expressed by means of curves which show the variation of electric conductivity, temperature coefficient of resistance, thermoelectric power, and e.m.f. as the proportion of silver in the alloy is increased ; the curves indicate the existence of two definite compounds, Al_3Ag_2 and $AlAg_3$. [See also Abstract No. 484 (1910).] G. E. A.

1141. *Conductivity of Insulators and its Alteration by Light, Moisture, Temperature, &c.* **W. Dietrich.** (Phys. Zeitschr. 11. pp. 187–189, March 1, 1910.)—The method of measuring the conductivity employed by the author consists in connecting two differently charged electroscopes by means of a rod of the insulating material and measuring the rate of discharge. The insulating properties are altered considerably by ultra-violet rays, especially when oxygen has access, and also by moisture. With glass, adjacent portions of the same piece often differ markedly in insulating power. With rise of temperature the resistance invariably diminishes according to an exponential law. In general Koenigsberger's law, $W = W_0 e^{-q/273T}$, is confirmed [Abstract No. 98 (1908)], q representing the heat of dissociation. Since this expression is not obeyed strictly, it is possible that the heat of dissociation may vary with temperature. The values of W_0 and q are given for a number of insulators. T. H. P.

1142. *Weston Cell as Standard of E.M.F.* **S. W. J. Smith.** (Phil. Mag. 20. pp. 206–228, July, 1910. Paper read before the Physical Soc., May 27, 1910.)—This paper contains an explanation of F. E. Smith's recent experiments on cadmium amalgams [see Abstract No. 771 (1910)] in terms of the theory of solutions. A description of the process of crystallisation of binary alloys shows that the surface of a "slowly" cooled amalgam will generally contain a lower percentage of cadmium than the material as a whole, and may even be fluid, although the temperature and percentage composition are such that the material should (in true equilibrium) be a uniform solid. It is also shown that in the presence of $CdSO_4$ solution electrolytic surface-effects, arising from the lightness and want of uniformity of composition of the solid grains, may result in the whole of the surface film becoming solid and of uniform composition, although there may still be an appreciable quantity of fluid alloy underneath. Many of the minor irregularities of Weston cells are believed to be due to this. Finally, it appears that the e.m.f. must rise as the percentage of Cd rises, but with two-phase amalgams the variations are exceedingly small. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

1143. *Distribution of Isodynamic Lines between the Poles of an Electromagnet.* **O. M. Corbino.** (Accad. Lincei, Atti, 19. pp. 540–544, May 1, 1910. Phys. Zeitschr. 11. pp. 521–526, June 15, 1910.)—A thin trough of Bravais' iron solution is placed in the gap of the electromagnet and monochromatic light, produced by means of a Rowland concave grating, passed through the trough normally to the field, the light traversing crossed nicols at 45° to the field. The amount of double refraction in the liquid depending upon the strength of field (Majorana-effect) [see Abstract No. 55 (1908)], an interference pattern is produced upon the screen. Since successive lines correspond to increments in difference of path of one wave-length, the lines indicate the variation in strength of magnetic field. Eight photographs are given. S. G. S.

1144. *Method of measuring a Magnetic Field in Magnitude and Direction.* **L. Dunoyer.** (Comptes Rendus, 150. pp. 1679–1682, June 20, 1910.)—Description of an apparatus which consists essentially of two bar magnets separately movable round the same vertical axis. If of equal moment M and placed in a uniform field H, the direction of the field will bisect the angle 2α between their magnetic axes, and an expression is given for H in terms of α, containing h the vertical distance of the two magnets and $2l$ the pole distance. Curves are drawn for different values of $h/2l$; for $h/2l > 4$ the curve approaches very closely the sinusoidal form $(H/M)\, 8l^3 = A \cos \alpha$, where A is a constant. The principle is applied in an instrument called a dygograph, for obtaining the variation of H on board ship due to the ship's magnetism. By attaching an articulated, lozenge-shaped system of bars with one corner on the vertical axis and the opposite one carrying a pencil, the two bars which radiate from the centre can be set over the two magnets and an elliptical trace on paper is made as the ship is continuously turned. From this trace (dygogram) the compensation can be rapidly effected and the table of deviations calculated. G. E. A.

1145. *Earth Currents in Stockholm during Transit of Halley's Comet.* **D. Stenquist** and **E. Petri.** (Nature, 84. p. 9, July 7, 1910.)—Observations were made at the central telegraph station at Stockholm of earth currents on two lines, Stockholm-Göletorg (resistance 2940 ohms) and Sundsvall-Stockholm (resistance 2886 ohms). Measurements made from minute to minute from 0h. 40m. to 3h. 45m. a.m. (mid-European time). The measured currents were considerably above the normal for the time of day, but not so large as during the occurrence of a magnetic storm. The greatest disturbances occurred shortly before and after 2·0 a.m., when the p.d. E.–W. $= +68{\cdot}1$, and that N.–S. $= +56{\cdot}6$ millivolts per km. C. P. B.

1146. *Phenomena of Magnetic Disturbances at Kew.* **C. Chree.** (Roy. Soc., Phil. Trans. 210. pp. 271–306, May 10, 1910.)—The paper deals with magnetic phenomena on highly disturbed days, in continuation of papers dealing with effects of specially selected type which have already been published [Abstracts Nos. 862 (1904), 1167 (1908)]. It had been noticed that the mean value of the non-cyclic changes of declination derived from 209 disturbed days had the same sign as the mean for the average quiet day. There was also a peculiar oscillation of sign in non-cyclic changes. If we compare the results from the first and second days of a sequence of disturbed days there is an evident tendency to an oscillation, generally represented by a fall in all three elements (D, H, V) during the first day, and a rise during the second. In dealing with the absolute ranges of the diurnal variation there is the added complication that the amplitude of the regular diurnal inequality alters with the epoch of sun-spot frequency. These quantities are given in tabular form; the mean value for D is the largest in every month except

July, and that for V is invariably the least. Curves are given showing the diurnal inequalities from disturbed days for each month, and also comparison curves showing the alteration of times of minimum on disturbed and quiet days. In discussing the best method of utilising the data now being provided by the international magnetic stations, it is suggested that three types of days be adopted, *quiet*, *intermediate*, and *highly disturbed*, and diurnal inequalities formed from each of these groups separately. C. P. B.

1147. *Magnetic and Electric Variations, May* 18–19, 1910. **A. Angot.** (Comptes Rendus, 150. pp. 1871–1872, May 23, 1910.)—In connection with the passage of Halley's comet across the plane of the earth's orbit on May 18, and the possible contact with the tail, numerous observations of atmospheric and magnetic phenomena were specially organised. At Val-Joyeux the vertical force presented no appreciable disturbance. The horizontal force, on the contrary, varied to a considerable extent; the principal movement was a progressive increase from 0h. 30m. to 1h. 19m. (Paris time), followed by an equal diminution, the total amplitude being 0·00037 c.g.s. The declination showed a diminution of 9·4′ from 0h. 55m. to 1h. 58m., followed by an equal increment. This was greater than had been observed on either May 18 or 19. Measures of electric potential only showed variations comparable to those shown during the passage of an ordinary storm cloud. It thus appears that none of the phenomena recorded showed any outstanding variations on the night in question. C. P. B.

1148. *Magnetism of Solutions.* **P. Drapier.** (Journ. Chim. Phys. 7. pp. 385–404, 1909.)—The solutions examined were placed in a thin vertical cell in the air-gap of a powerful electromagnet. Paramagnetic liquids, tending to move radially in a plane normal to the lines of force, develop a convexity at the surface, which is increased when the surface tension (of aqueous solutions) is lowered by addition of ether or benzene. A 1 per cent. aqueous solution of ferric alum or ferric chloride shows a convexity even, but a solution of the same concentration in ether is unaffected. Ferric ammonium oxalate is but slightly affected, and colloidal ferric hydroxide, potassium ferrocyanide, and potassium ferricyanide are unaffected. If a solution of ferric chloride in ether is floated on water a striated layer is produced, which, in the field, bends downwards into the water, the striæ being displaced horizontally. Dilute manganese sulphate gives a marked convexity, but potassium permanganate none. Cobalt and nickel hydroxides precipitated by ammonia are also very sensitive to the magnetic field. Chromium sulphate, cobaltous chloride, and nickel nitrate are paramagnetic; potassium dichromate, potassium cobalticyanide, titanium sulphate, and platinum chloride are not. The author's observations confirm Pascal's conclusion that as a magnetic metal becomes more and more removed from its normal (ionised) state it loses its paramagnetism. The magnetic capillary rise of 5, 7½, and 10 per cent. solutions of ferric alum and ferric chloride was investigated. On increasing and decreasing the exciting currents between 0 and 10 amps. marked hysteresis was found in the capillary rise, apart from the usual hysteresis of the magnet. This effect is thought by the author to be true liquid hysteresis. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1149. *A New Resistance Furnace.* **F. A. J. FitzGerald.** (Metallurg. and Chem. Engin. 8. p. 317, June, 1910.)—A furnace is described in which the charge in the crucible is heated by radiation from resistance; this, in some forms, may be described as a furnace with a sealed reaction or heating chamber. This type of furnace has been used for the experimental production of zinc. The efficiencies of these furnaces have been determined at about 78 per cent. It is pointed out that in certain forms of electric furnace it is possible nearly to eliminate the loss of electrically generated heat by surrounding it with an envelope of burning gas. Experiments on large furnaces have shown that this modification introduces very great economies. C. O. B.

1150. *Atomic Weight of Radium Emanation.* **A. Debierne.** (Comptes Rendus, 150. pp. 1740–1743, June 27, 1910.)—Investigations have been made by many observers on the atomic weight of RaEm, but the results are not very concordant. In the present investigation a modification of Bunsen's method of determining the density of a gas has been used, based on observations of the speed of escape of different gases through a small hole in the vessel containing them. In the experimental arrangement two glass vessels were separated by a thin sheet of Pt 1/100 mm. in thickness, pierced with a very small hole. In one of the vessels was placed the gas under observation, while the other was connected to a continuously running Gaede pump. The pressure of the gas was measured by a McLeod gauge, and it was found that the pressure decreased exponentially with time at a rate depending only on the density of the gas. Observations were made with mixed gases, and it was found that each gas escaped as though it were alone. The observations were extended to RaEm, the equilibrium of activity being measured instead of the pressure, and the same laws were found to hold, the rate of escape giving a value of 220 (± 2 per cent.) for its molecular weight. Assuming RaEm to be monatomic, this value also represents its atomic weight, and is very near to that obtained from the disintegration theory by subtracting the atomic weight of He (4) from that of Ra (226·5). E. M.

1151. *Electric Oxidation of Nitrogen by Direct-current Arcs with Cooled Anodes.* **W. Holwech.** (Zeitschr. Elektrochem. 16. pp. 369–390, June 1, 1910.)—The experiments were made under Haber and with the assistance of A. Koenig. The apparatus resembles that of Morden [see Abstract No. 1187 (1909)]. The vessel is a glass balloon, joined to an air-pump. The anode is a vertical tube of silver, water-cooled, through which the gases are withdrawn upwards; the air enters through a pipe from below; the kathode is a foil of iridium, held by nickel and coated with lime: in spite of this coating the iridium always melted within less than 2 hours. To strike the arc the balloon is evacuated to 100 mm. pressure, when the glow discharge sets in which, on raising the gas pressure, passes into the arc discharge. Potential and temperature measurements were made with the aid of an exploring wire of Pt or a foil of Ir, 0·08 mm. in thickness, cut to a point. Morden's results are on the whole confirmed. The yield reached 80 gm. HNO_3 per kw.-hour at a max. concentration of more than

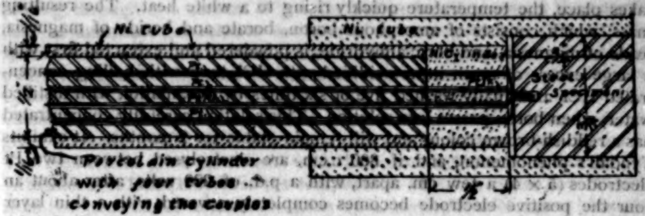
9 per cent. of NO, in air. High concentration is best attained with short arcs (0·8 to 4 mm. tried, in special experiments 8 mm.), small air speeds, strong electric fields, and arc temperatures not exceeding 2000° C. By cooling the anode the potential gradient can be kept nearly constant except at points close to the electrodes. As the anode and kathode fall of potential do not extend far, they have little influence upon the thermal relations; the essential feature is the watt consumption. The iridium point never melted. The temperature in the arc, therefore, never exceeded 3000° abs., assuming that Ir melts at 2300° C.; Nernst's views of a purely thermal formation of NO would demand much higher temperatures. The just-mentioned figure applies to atmospheric pressure and a distance of the sound from the electrode equal to 4 mm.; with lower pressure and smaller distance the temperature would remain lower. The potential gradient in the light column of the arc—always direct current—ranged from 100 to 200 volts/cm., while technically long arcs with gradients of 10 volts/cm. yield almost the same amount of NO, though at smaller concentrations. The oxidation of nitrogen would therefore appear to be chiefly electrical in short arcs, and chiefly thermal in long arcs. H. B.

1152. *Absorption of β-Rays by Solutions.* **W. A. Borodowsky.** (Phil. Mag. 19. pp. 605–619, April, 1910.)—The author has determined the absorption by various liquids and solutions, of the β-rays from radium bromide in equilibrium. With the purpose of obtaining results independent of the type of β-rays employed the thicknesses of layers of liquids were compared with the thickness of Al which produced the same absorption. The author finds that the absorption by a liquid in terms of Al is directly proportional to the mass of liquid present; while when two liquid reagents are mixed the absorption of the mixture is equal to the absorption before mixing, even in the case when a precipitate is formed. The absorption of liquids and solutions was found to follow the same laws as that of solids, being additive in the case of compounds; while the absorption by a salt in solution was found to be directly proportional to the amount of salt present. E. M.

1153. *Chemical Action at High Pressures. Compression of Nitrous Oxide and of a Mixture of Nitrogen and Hydrogen. Decomposition of Carbon Monoxide by Pressure.* **E. Briner** and **A. Wroczynski.** (Comptes Rendus, 150. pp. 1824–1827, May 23, 1910.)—In continuation of former experiments [Abstract No. 464 (1910)] the authors have studied the influence of pressure at different temperatures on the gases mentioned above. In the case of nitrous oxide no decomposition was detected when the gas was subjected to a pressure of 600 atmos. at temperatures up to 420°. In the case of mixtures of nitrogen and hydrogen, similarly, no combination was observed at pressures up to 900 atmos. at the ordinary temperatures. In the case of CO, which is an endothermic substance, and which is decomposed by elevation of temperature, more especially in presence of such catalysts as nickel powder, it was found that no decomposition occurred when the gas was subjected to pressures of as much as 800 atmos. at the ordinary temperature. Decomposition occurs, however, at a pressure of 400 atmos. when the temperature is raised to 820°. Under a pressure of 600 atmos. at the same temperature a decomposition amounting to 10 per cent. was attained after 20 hours. Besides the formation of CO_2 there was a grey-black deposit the nature of which has not yet been ascertained, but which the authors regard as either carbon or a lower oxide of that element. [*Erratum*, p. 1714, June 20, 1910.] A. F

1154. *Effect of Hydrogen on Platinum and Nickel Wire at High Temperatures.* **M. v. Pirani** and **A. R. Meyer.** (Zeitschr. Elektrochem. 16. pp. 444–447, June 15, 1910.)—Changes in the electrical and physical behaviour of Ni and Pt wires, at a high temperature, are noticed when they are subjected to a stream of hydrogen. In the case of Ni an increase in resistance was observed, while in the case of Pt a more remarkable effect was noticed, namely, a lowering of the melting-point by 250 to 300°, accompanied by a marked reduction in ductility. The question therefore arises whether this is due to the effect of the hydrogen itself or to some incidental impurity. It might be caused (1) by an occlusion of hydrogen by the metal in question; (2) by the effect of impurities in the hydrogen supplied; or (3) by gases emerging from the quartz tube used to enclose the gas (after having been absorbed by the tube in the electric furnace). The authors then proceed to describe a series of experiments designed to discriminate between these different possibilities. They finally dismiss the first and third hypotheses, and show that the effect was probably due to the presence of hydrocarbons in the hydrogen. These hydrocarbons are decomposed at a high temperature with the result that carbon is deposited on the Pt and so affects its apparent physical properties. It may be added that these phenomena do not occur when *stationary* hydrogen is used, nor when nitrogen is used instead of hydrogen. The reason for the latter circumstance is probably that the nitrogen contains traces of oxygen as an impurity, and this oxidises the impurities and prevents their deposition on the metal. J. S. D.

1155. *Methods of determining the Critical Points of Steel.* **G. W. Sargent.** (Frank. Inst., Journ. 169. pp. 253–271, April, 1910.)—The author gives a brief account of the methods used in taking cooling-curves of various types, and for steel prefers autographic differential curves obtained by means of the Saladin apparatus. A nickel blank body has been adopted, the arrangement of couples being shown in the accompanying Fig. Some very fine heating and cooling curves are reproduced, and micrographs are given illustrating the structures of specimens quenched at various stages during the critical ranges. In 1907 the U.S. Ordnance Dept. specified that for rifle-barrel steel, tensile test-pieces should be cut from samples annealed at 10–20° C. above the Ac′ point. F. C. A. H. L.



1156. *Equilibrium between a Dilute Solution and the Pure Solvent Separated by a Semipermeable Diaphragm, or by the Vapour of the Solvent.* **G. Guglielmo.** (Accad. Lincei, Atti, 18. pp. 536–544, Dec. 5, 1909.)—From van der Waals' equations $\Sigma mV^2 = 3(P + p)$ and $\Sigma mV^2 = 3[K + H/2(1/\rho + 1/\rho_1)]$, the author deduces two forms of the condition for equilibrium of the molecule of a chemically homogeneous liquid. It is finally deduced that in a dilute solution the attraction of the dissolved body for the solvent equals the pressure of the solute, considered as a gas, and hence at constant temperature does not depend on the molecular weight of either solvent or solute, or entirely on the number of molecules of the latter per cm^3., but increases directly as the absolute temperature. The independence of the attraction of the mass explains the equality of the vapour pressures of equimolecular solutions of different substances in the same solvent. The lower vapour pressures of solutions with respect to the solvents is attributable to the smaller number of molecules evaporating per cm.^{2} of surface, and to the attraction of the solute for the solvent, which retards its evaporation and facilitates its condensation. The influence of curvature of the surface of a liquid on its vapour pressure is also discussed. W. H. Si.

1157. *Colloidal Solution of Pure Arsenic.* **Lecoq.** (Comptes Rendus, 150. pp. 700–702, March 14, 1910.)—A colloidal solution of arsenic, free from impurities and stable in a neutral or acid medium, may be prepared by (1) electrolysing an alkaline solution with an anode of arsenic, best in presence of a stable colloid, the magnitude of the colloidal granules depending on the concentration of the solution in alkali, the p.d., and the distance between the electrodes; (2) electro-reduction of an alkaline solution of arsenious acid, the solution thus obtained containing small granules and being considerably more stable than those prepared according to (1). These solutions are deep reddish-brown in colour. T. H. P.

1158. *Colloidal Boron.* **F. Ageno and E. Barzetti.** (Accad. Lincei, Atti, 19. pp. 381–382, April 3, 1910.)—The authors have prepared colloidal solutions of boron by fusing together in a gas furnace an intimate mixture of boric anhydride (3 parts) and powdered Mg (1 part) contained in a crucible of refractory earth. The mixture is heated to redness, when violent reaction takes place, the temperature quickly rising to a white heat. The resulting mass, which consists of amorphous boron, borate and boride of magnesia, oxide of magnesia, and boric anhydride, is powdered and extracted first with a large excess of warm water acidified with HCl, then with boiling concentrated HCl, and finally washed five or six times by decantation with distilled water, when boron passes into solution. This solution carefully concentrated has a reddish-brown colour and will remain stable for 2 months. It exhibits Tyndall's phenomenon, and if 300 c.cm. are electrolysed between two Pt electrodes (5 × 4) a few cm. apart, with a p.d. of 220 volts, after about an hour the positive electrode becomes completely covered with a thin layer of amorphous boron, while the negative electrode remains perfectly bright, showing colloidal boron is electrically negative. Hydrogen peroxide decomposes colloidal boron with formation of boric acid. Slight traces of electrolytes completely precipitate the boron from solution in a very short time. W. H. Si.

1159. *Electrochemistry of Light.* IX. *Theory of Solarisation.* Part III. **W. D. Bancroft.** (Journ. Phys. Chem. 14. pp. 292–319, April, 1910.)—In this paper and the preceding ones [Abstract No. 99 (1910)] experimental proof has been produced for the two following postulates of the author's working hypothesis: (1) The action of light on a silver halide corresponds with that of a direct current or of a fairly weak reducing agent, and causes the halide to pass through all the possible stages of reduction. (2) A moderately strong reducing agent (developer) does not cause the silver halide to pass through all the possible stages, but reduces certain silver-halogen solid solutions or sub-halides more rapidly than others which contain less halogen. This theory has been applied to a large number of specific cases and accounts for all the known observations; it has also been used for the prediction of new facts. T. H. P.

1160. *Pulfrich's Relation between Contraction of Volume and Refraction of Mixed Liquids.* **E. van Aubel.** (Comptes Rendus, 150. pp. 210–218, Jan. 24, 1910.)—Application of Pulfrich's relation, connecting volume contraction and refraction $(R - R_v)/R = q(D - D_v)/D = qc$, to some results obtained by Wintgen (Thesis for Doctorate, Bonn, July, 1908) shows that the constant q is not invariably positive, as stated by Pulfrich, a mixture of an aqueous solution of ammonium heptmolybdate with an aqueous solution of tartaric acid giving $D < D_v$, and $R > R_v$, whence q is negative. [See also Abstract No. 186 (1909).] W. H. Si.

1161. *Reduction of the Chlorides of Boron and Arsenic by Hydrogen under Influence of the Electric Discharge.* **A. Besson** and **L. Fournier.** (Comptes Rendus, 150. pp. 872–874, April 4, 1910.)—Arsenic trichloride is reduced by hydrogen under the influence of the electric discharge, yielding another chloride, probably $As_{11}Cl$. Boron trichloride vapour is not reduced under these conditions, but the gaseous mixture seems to be possessed of considerable electrical conductivity, so that, with a suitable apparatus, sparks several cm. long are formed with a cracking noise, the tube becoming heated and often breaking: boron is liberated and deposited on the tube. T. H. P.

1162. *Specific Heat and Chemical Equilibrium of Gaseous Ammonia.* **W. Nernst.** (Zeitschr. Elektrochem. 16. pp. 96–102, Feb. 1, 1910.)—By measuring the change of temperature of a silver calorimeter produced by passing through it a current of gas, the author has determined the specific heat of ammonia gas relative to those of water-vapour and CO_2, and the specific heats of the two latter relative to that of oxygen. The results show that for the molecular heat of ammonia at constant pressure, the equation $C_p = 8{\cdot}62 + 0{\cdot}0020t + 7{\cdot}2t^2/10^6$ holds up to a temperature of about 700°. Calculation of the heat of formation of ammonia from its elements at 850° gives the value 30,220 cals., which is inaccurate by not more than 1500 cals. This result is in good agreement with the value, 28,000 cals., found by Jost [Abstract No. 1521 (1908)] for the temperature 866°, but differs considerably from the value 24,000–25,600 cals. given by Haber and Le Rossignol [Abstract No. 1522 (1908)] for the temperature interval, 700–1000°. Taking the value 24,000 cals., given by Thomsen for the heat of formation at 0°, the variation with temperature can be calculated by means of the equation, $Q = Q_0 + 9{\cdot}70t - 0{\cdot}0002t^2 - 8{\cdot}6t^4/10^9$. The formula, $\log K = \log [H_2]^3[N_2]/[NH_3]^2 = -21980/4{\cdot}571T + 8{\cdot}5 \log T + 0{\cdot}00881T/4{\cdot}571 - 0{\cdot}81T^2/4{\cdot}571 \times 10^6 + 0{\cdot}440$, gives values for the equilibrium constant which are in good agreement with those found by Jost. The above results are discussed in connection with the author's heat theorem, which gives a satisfactory explanation of them.

T. H. P.

1163. *Photo- and Electro-chemical Equilibria.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 856–859, Nov. 25, 1909.)—The author discusses the absorption of electrical and light energy by various systems leading to the establishment at the ordinary temperature of equilibria which are also obtainable, but at much higher temperatures, by supplying heat energy. When the quantity of electrical or light energy transmitted is so great that, during the passage of the energy current, no decrease of the energy is observable, although energy is absorbed by the system, the system is to be considered as in all respects homogeneous, and the law of mass action must be applicable. If, however, the current of energy is less intense, so that decrease of energy evidently occurs, the condition will vary from layer to layer, and the law of mass action will not hold. Complications may, however, occur; thus, Le Blanc and Davies [Abstract No. 1850 (1908)] found that, with the action of the silent discharge on the reaction: $3H_2 + N_2 \rightleftarrows 2NH_3$, the law of mass action does not hold, the energy being subjected to some change, by which, in some cases, peculiar light-phenomena are produced. T. H. P.

1164. *Osmotic Experiments with Collodion Membranes.* **J. H. Mathews.** (Journ. Phys. Chem. 14. pp. 281–291, April, 1910.)—Osmotic experiments on a number of solutions with collodion membranes lead to the following conclusions: Whether osmotic action through a membrane takes place or not seems to be dependent on the solubility of at least one of the components in the membrane. Whether an increase in volume of the solution takes place or not depends on the miscibility of the solvents used. The direction and extent of the osmotic action are evidently largely a question of relative solubility, the process being akin to a distribution process. When osmotic action occurs it consists of a major and minor current, in opposite directions. It was repeatedly observed that the osmotic process is hastened by stirring of the liquids bathing the membranes. These conclusions confirm the results obtained by Kahlenberg [Abstract No. 1142 (1906)] from a study of other membranes, and the views of this author on the nature of the osmotic process. T. H. P.

1165. *Solubility of Xenon, Krypton, Argon, Neon, and Helium in Water.* **A. v. Antropoff.** (Roy. Soc., Proc. Ser. A. 83. pp. 474–482, April 14, 1910.)—The author has determined the solubility of the above gases in water at temperatures from 0° to 50°. [Cf. Abstracts Nos. 872 (1900), 1759 (1908)]. The results are as follows: Except in the case of He and Ne, the determinations possibly being erroneous for one of them, the solubility rises with increase of atomic weight. Thus for example, at 20°, the solubilities are He 0·0138; Ne, 0·0147; Ar, 0·0379; Kr, 0·0670 and 0·0788 (the reason for the difference in the two values is not known); Xe, 0·1109. The solubility of xenon is greater than that of any other gas which does not form a compound with the solvent. In the case of all the rare gases, there is a distinct minimum of solubility. The minimum for Xe and Ar lies at 40°; for Kr between 30° and 40°; for He at 10°; and for Ne probably at 0°. A. F.

1166. *Solubility of Gold in Nitric Acid.* **F. P. Dewey.** (Amer. Chem. Journ. 32. pp. 318–323, March, 1910.)—In view of the varying data published concerning the solubility of gold in nitric acid, the author has carried out experiments which show that gold is dissolved to some extent when treated with the boiling, highly purified acid. The method employed to determine the amount of gold in the strongly acid solutions is described. T. H. P.

1167. *Influence of Colloids and Fine Suspensions on the Solubility of Gases in Water.* I. *Solubility of Carbon Dioxide and Nitrous Oxide.* **A. Findlay** and

H. J. M. Creighton. (Chem. Soc., Journ. 97. pp. 556–561, March, 1910.)—The solubility of CO_2 in water is increased by the addition of ferric hydroxide, silicic acid or gelatin, but is decreased by dextrin, arsenious sulphide, starch, albumen, and glycogen; powdered silica produces a slight increase of solubility, and charcoal a large increase when the pressure is increased. In the case of nitrous oxide the solubility is decreased by ferric hydroxide, starch, glycogen, gelatin, and albumen; silicic acid and suspended silica produce a small increase, whilst suspended charcoal produces a large increase at higher pressures. A remarkable feature of the observations is the existence in many cases of a minimum of solubility at intermediate pressures; this points to the existence of two opposing actions, *e.g.*, an "adsorption" causing an increase of solubility at higher pressures, and some other factor causing a decrease; the nature of this second factor is very uncertain, but the polymerisation of the gas condensed by the colloid is discussed as a possible interpretation.

T. M. L.

1168. *Adiabatic Determination of Heats of Solution of Metals in Acids.* I. **T. W. Richards** and **L. L. Burgess.** (Amer. Chem. Soc., Journ. 32. pp. 431–460, April, 1910.)—The adiabatic method used depends on surrounding the calorimeter with an alkaline liquid which is heated by the addition of an acid in such a way as to keep its temperature identical with that in the calorimeter itself. The chief advantages of the method are that cooling-corrections are eliminated and that slow heat-changes can be investigated as well as rapid ones. The following values were deduced for the heat of solution of the metals in an excess of hydrochloric acid at 20°:—

Metal.	Concentration of Acid.	Weight of Metal Dissolved.	Heat Evolved in Experiment (in Small Cals.)	Atomic Weights.	Heat Evolved for 1 Gm.-Atom of Metal. In Large Cals. (20°).	Heat Evolved for 1 Gm.-Atom of Metal. In Kilo-joules.
Zn	+ $HCl\,20H_2O$	7·496	3462	65·37	30·19	126·3
Al	+ $HCl\,20H_2O$	0·7470	3474	27·1	126·0	527
Mg	+ $HCl\,200H_2O$............	0·8492	3846	24·32	110·15	460·6
Cd	+ $HCl\,8.8H_2O$	14·985	2635	112·42	19·77	82·68
Fe	+ $HCl\,8.8H_2O$............	9·000	3312	55·85	20·55	85·94

The values given cannot be compared directly with those of Thomsen until the heats of dilution of the acids are available, but several sources of error in the earlier methods have been discovered, and it is believed that an altogether higher degree of accuracy has been attained in the measurements now recorded.

T. M. L.

1169. *Viscosity and Fluidity.* IX. **E. C. Bingham.** (Amer. Chem. Journ. 19. pp. 287–309, April, 1910.)—The equation $t = A\phi - B/\phi + C$ has been found to represent fluidity data with great effectiveness, the underlying theoretical idea being that the fluidity of an ideal liquid would be directly proportional to the absolute temperature, but that in the case of actual liquids a correction must be made analogous to the well-known correction of van der Waals' equation. If the pressure is constant van der Waals' equation may be written in the form $t = a\phi - \beta - \gamma/\phi + \delta/\phi^2$ (where ϕ in this case represents volume), which differs only from the above fluidity equation in the presence of the last term; an equation containing this additional term has proved of value in representing the effect of temperature on fluidity in the more complex cases, such as that of water. Confirmation of the author's view that fluidity and volume are closely related is derived from a study of the fluidity of water in the neighbourhood of 4°, where a sagging of the fluidity curve accompanies the sagging of the curve of volumes. T. M. L.

1170. *Fundamental Law for a General Theory of Solutions.* **E. W. Washburn.** (Amer. Chem. Soc., Journ. 32. pp. 653–670, May, 1910.)—The author calls attention to the fact that a rigid thermodynamic relationship exists between osmotic pressure and freezing-point, boiling-point, or vapour pressure, and between vapour pressure and freezing-point, and that the theory of solutions would be applicable alike to strong and weak solutions if these differential equations could be integrated. This can be done for dilute solutions, but the author shows that it is also possible for an ideal solution which contains only two kinds of molecules mixed together. Many solutions obey the laws deduced for the ideal solution, and others do so if the presence of a third (complex) type of molecule is postulated. The method is limited, however, to liquids which are similar in general character, as the theory gives no indication of the possibility of two immiscible or partially miscible liquid layers. T. M. L.

1171. *Solubility of Hydrogen and Oxygen in Solid and Fused Silver.* **A. Sieverts** and **J. Hagenacker.** (Zeitschr. Phys. Chem. 68. 1. pp. 115–128, Oct. 26, 1909.)—The solubility of oxygen in silver is as follows :—

	10 Gm. Dissolve.	1 Vol. Dissolves.
923° (solid)	0·54 c.cm.	0·54 vols.
973 (liquid)	21·35 "	20·28 "
1024	20·56 "	19·53 "
1075	19·39 "	18·42 "
1125	18·49 "	17·56 "

If Henry's Law held good the ratio p/m should be constant for different values of the pressure p; this is not the case, as the concentration m varies as the square root of the pressure, very steady values being given for $\sqrt{p}/m$ at 1075° and again at 1125°. From the experimental values for the solubility of pure oxygen in silver, the solubility in contact with air is calculated to be 9 vols. of oxygen per 1 vol. of silver at 1075°, agreeing closely with the amount found in fused silver which has been quenched in water. The value for the solubility of oxygen at 973° agrees closely with that found by Gay Lussac (22 vols.) for silver melted under saltpetre. The square-root law has been observed for the solubility of hydrogen in Pt, Pd, Ni, and Cu, and for oxygen in Au-Ag alloys; it can be explained by assuming that the gas enters the metal in the form of atoms. The solubility of hydrogen in Ag is practically zero both for the fused and for the solid metal. T. M. L.

1172. *Formamide as a Solvent for Inorganic Salts and the Electrolysis of the resulting Solutions.* **H. Röhler.** (Zeitschr. Elektrochem. 16. pp. 419–436, June 15, 1910.)—Although formamide is very similar to water in many of its properties, it possesses a large dielectric constant, mixes with alcohol in all proportions, but not with ether, &c.—it does not show a point of max. density in the neighbourhood of the melting-point. The relation between the density and the temperature is a linear one. A number of salts were dissolved in formamide and the solutions electrolysed, using a Pt kathode and an anode of the respective metal. Attention was paid to the amount of metal dissolved from the anode and the amount deposited on the kathode, as compared with the amount of copper deposited in a voltameter in series. These results were often discordant, owing to the influence of atmospheric oxygen; in most cases they became concordant when air was excluded. When salts—for example, chlorides—are dissolved in formamide, reactions take place which may be represented by the following equilibrium equation: $n\,\mathrm{H.CONH_2} + \mathrm{MCl_2} \rightleftarrows \mathrm{(H.CONH)_2M}\,.\,x\,\mathrm{HCONH_2} + 2\,\mathrm{HCl}\,.\,y\,.\,\mathrm{HCONH_2} + (n-2-x-y)\,\mathrm{HCONH_2}$, where M may be Cu, Ni, Co, Pb, Sn or Zn, and in many cases the resulting metal-formamides have been isolated. The acid combined with the formamide, as a result of the above reaction, still possesses the power of dissolving metals, in some cases with evolution of hydrogen, in others only under joint action with atmospheric oxygen. This explains why the results of electrolysis were not concordant unless air was rigidly excluded, since ordinary chemical solution of the electrodes took place, as well as electrolytic solution. Zinc dissolved in a solution of zinc chloride in formamide, even when air was excluded. Conductivity measurements on solutions of the metal-formamides in formamide, in particular of sodium formamide in formamide, showed that the migration velocity of the H . COONH′-ion, which is common to both solvent and solute, is not especially great, in contradiction to what is generally the case with other ions in a solvent containing the same ion. T. S. P.

1173. *Estimation of Radium.* **S. J. Lloyd.** (Journ. Phys. Chem. 14. pp. 476–481, May, 1910.)—The paper deals with the estimation of amounts of Ra by the emanation produced in a solution of the radium salt in a known time. The author has investigated the effect of the presence of various reagents and precipitates in the solution of the radium salt. He finds that for an accurate determination of Ra by the above method the presence of HCl or HNO_3 is necessary. If $BaSO_4$ or $BaCO_3$ is present in the solution, prolonged boiling or repeated determinations will be necessary. He concludes that in the case of freshly precipitated $BaSO_4$ the retention of the emanation is mechanical only, due to the entanglement of radium chloride or sulphate within the fine precipitate, the effect of heat being to release the Ra and permit the removal of the emanation. E. M.

1174. *Comparison of Methods for depositing Iron Electrolytically.* **S. A. Tucker** and **E. Schramm.** (Ind. and Engin. Chem., Journ. 2. No. 6. Chem. News, 102. pp. 16–17, July 8, 1910.)—[see Abstract No. 1349 (1908)]. The experiments described include the sulphate and chloride baths, and in most cases they were carried out at room temperature. The kathodes were clean sheet iron and the anodes consisted of wrought iron plates. The sulphate baths consisted of ferrous ammonium sulphate, ferrous ammonium sulphate containing a small quantity of glycerine, ferrous ammonium sulphate with magnesium sulphate and sodium hydrogen carbonate, and ferrous sodium sulphate respectively. It was found that the solution containing 200 gm. of ferrous ammonium sulphate per litre was the best as regards character of deposit, permanent good condition of the electrode and energy efficiency. The chloride baths consisted of ferrous chloride with ammonium chloride. The current efficiency was practically the same as with the sulphate baths, but the energy efficiency at any given current-density was much higher for the chloride solution. The more concentrated the chloride solution (the solutions used contained 100 gm. of $FeCl_2\,4H_2O$ + 50 gm. of NH_4Cl per litre, and 200 gm. of $FeCl_2 4H_2O$ + 100 gm. of NH_4Cl per litre) the higher was the energy efficiency at any given current-density. The physical character of the deposit from the chloride solution is somewhat different from that deposited from the sulphate solutions, being more crystalline than the latter, excepting that to which glycerine has been added. Experiments with a solution of ferrous chloride containing sodium chloride (285 gm. of $FeCl_2 4H_2O$ + 102 gm. of NaCl per litre) at temperatures between 30° and 60° C. showed that the voltage decreases with increased temperature and also as the run proceeds; the best energy efficiency is attained between 50° and 70° C. This bath also gave the best and thickest deposits, the iron being grey and non-crystalline. Both with the sulphate and chloride baths the current efficiency was over 95 per cent. T. S. P.

1175. *Electrolytic Formation of Floating Zinc Crystals.* **H. Freundlich** and **W. Novikow.** (Zeitschr. Elektrochem. 16. pp. 394–400, June 1, 1910.)—Mylius and Fromm observed in 1894 that, when commercial zinc sulphate is electrolysed with the kathode, a Pt point, just dipping into the electrolyte, the zinc crystals float, under certain conditions, on the surface and do not grow downward, provided the current density be not too great. Presence of at least 1 per cent. of oxygen in the atmosphere above the liquid was necessary for the phenomenon, but the presence of oxidising or reducing compounds in the electrolyte made no difference. The crystals were not observed in a vacuum. The authors confirm these statements. The phenomenon is prevented by the presence of ammonium salts, citric acid, tartaric acid, and potassium cyanide, and requires the presence of some liquid (oil, ether, benzene) which will not mix with the electrolyte and will float on the top; pasty liquids will also do. It appears that amorphous zinc is then first deposited and oxidised to spongy zinc, which the oil (always present in commercial sulphate if not very carefully purified) keeps floating; the oil also prevents the penetration of the current into the interior of the liquid. When the current is reversed the leafy crystals are dissolved, but not the skeleton of spongy zinc from which they had grown. The thickness of the oily stratum ranges with different oils and fatty acids from 0·5 to 2 $\mu\mu$. H. B.

REFERENCES.

1176. *Densities and Molecular Weights of Neon and Helium.* **H. E. Watson.** (Chem. Soc., Journ. 97. pp. 810–833, May, 1910.)—The weights of a litre of neon and helium under normal conditions are found to be 0·9002 ± 0·0008 and 0·1782 gm. respectively. The molecular weights are calculated to be 20·200 and 3·994. T. H. P.

1177. *Molecular Weights of Krypton and Xenon.* **H. E. Watson.** (Chem. Soc., Journ. 97. pp. 833–836, May, 1910.)—The author deduces the litre-weights, compressibility coefficients, and molecular weights of krypton and xenon, and gives a table showing the values of these constants for all the inactive gases. T. H. P.

1178. *Electro-analytical Determination of Lead as Peroxide.* **H. J. S. Sand.** (Faraday Soc., Trans. 5. pp. 207–211; Discussion, p. 211, Feb., 1910. Chem. News, 100. pp. 269–270, Dec. 3, 1909. Elect. Engin. 44. pp. 811–812, Dec. 10, 1909.)

1179. *Electric Transport Phenomena in Solutions of Certain Colouring Matters.* **L. Vignon.** (Comptes Rendus, 150. pp. 923–925, April 11, 1910.)—The author's experiments on the electrolysis of dilute solutions of certain dyes show that, when the latter form colloidal solutions, clearly defined transport phenomena are observed, whilst when the colouring matter forms a true solution such phenomena are absent. T. H. P.